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THE FOUNDRY

Vol. 38, No. 2 Cleveland, Ohio, April, 1911 Whole No. 224

AN EASTERN TROPENAS STEEL PLANT

Description of the handling and conveying appliances of a large foundry producing steel castings

By E. F. Lake

ECONOMY of production is of prime importance to every manufacturer and its attainment can largely be promoted by the layout of the various departments to facilitate the advantageous handling of raw materials and finished product. In the well-designed shop the raw materials travel through each department for the various manufacturing operations, in natural sequence until delivered to the shipping department in the form of finished product. In passing through the various stages of manufacture it is important that the material upon which work is being done shall be carried to the various departments by the shortest and most direct routes instead of being conveyed back and forth from one department to another. The cost of handling materials is at all times a large item of expense, especially in foundries, and unless reduced to the minimum the cost of production is greatly increased.

When designing the new foundry of the Bayonne Steel Casting Co., Bayonne, N. J., the plant was arranged with special reference to interdepartmental transportation facilities, and equipment was installed that permits of the handling of raw and finished materials to the best advantage. The main foundry building, shown in Fig. 3, is 266 feet long by 140 wide, and consists of a center span and two bays, only one of which extends the full length of the shop, the other being only 120 feet long, the cut-off providing space for the foundry store room, foundry office, laboratory and other detached buildings, as shown in

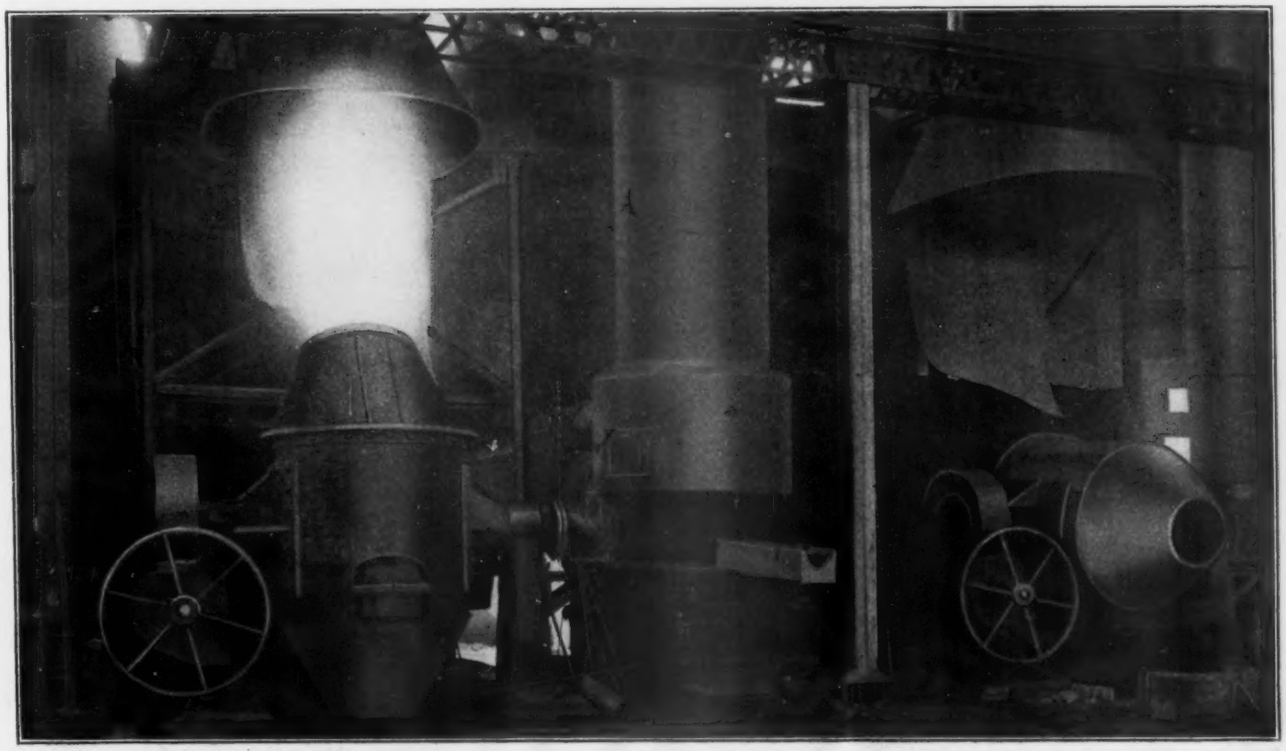


FIG. 1—STEEL MELTING EQUIPMENT IN THE FOUNDRY OF THE BAYONNE STEEL CASTING CO. ONE OF THE CONVERTERS IS IN OPERATION AND THE OTHER IS TURNED DOWN FOR REPAIRS

FIG. 2—SECTION OF ONE OF THE GREEN SAND MOLDING FLOORS

the plan view, Fig. 9. The building is of fireproof construction throughout, with a structural steel frame and corrugated sheet steel roof and siding. The foundry was originally located at Delawanna, N. J., where it had been erected by the Reliance Steel Foundry Co. The location, however, was unfavorable, owing to the lack of proper shipping facilities, and it was sold to its present owners, by whom it was torn down and shipped to Bayonne, where it was erected, the main building having been increased both in length and width. The Reliance plant was torn down, removed and rebuilt in record time. On May 16, 1910, the Bayonne company took possession of the Delawanna plant and on Aug. 20, following, the first heat was taken from the converter and poured into castings at the Bayonne plant.

During the month of September, 100 tons of steel castings were made and shipped. This was increased to 200 tons in October, 250 tons in November and 300 tons in December, during which time not a single heat was lost, a very encouraging record. The short bay was one of the additions to the main buildings and was erected to accommodate the core department, mold drying ovens and sand preparing machinery and storage bins, as shown in the plan view, Fig. 9. The sand and clay bins are located adjacent to the railroad siding, so that these materials can be directly unloaded from the cars into the bins and in close proximity to the latter are the sand grinding and mixing machines, Fig. 4. This arrangement permits the sand to be mixed and prepared for use with the least amount of handling, and the mixing machines being located handy

FIG. 3—THE MAIN FOUNDRY BUILDING, SHOWING ONE OF THE MOVABLE JIB CRANES AND THE MOLD DRYING OVENS

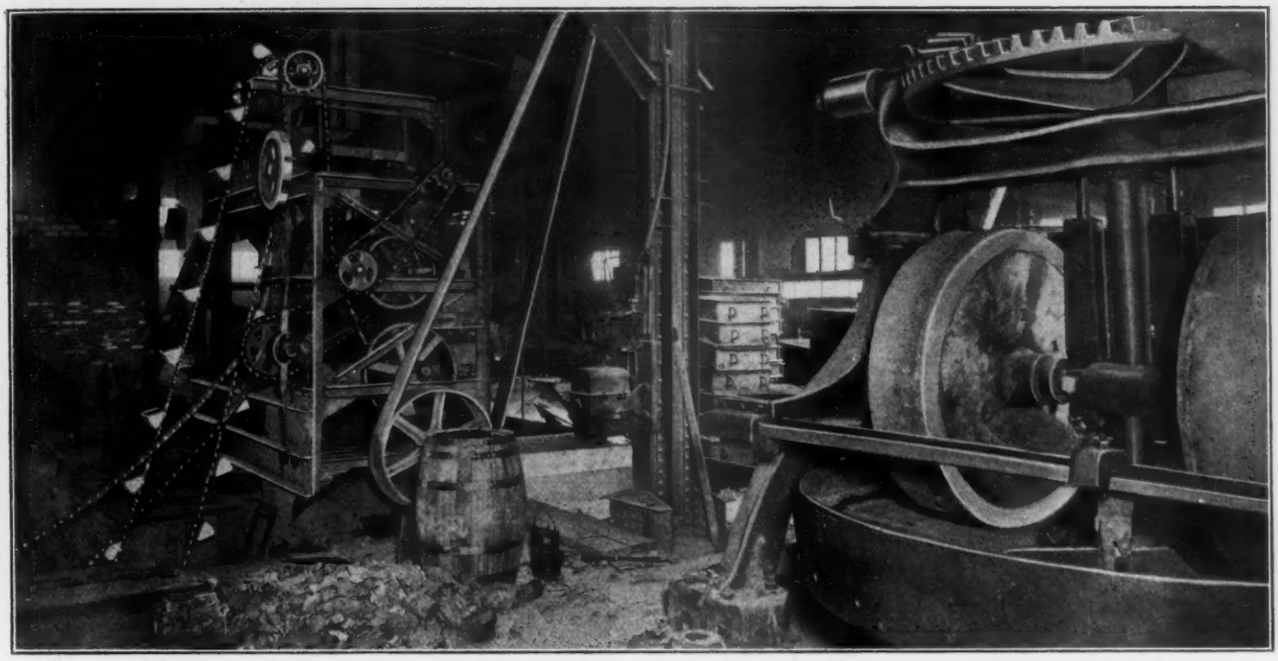


FIG. 4—SAND MIXING AND GRINDING EQUIPMENT IN THE FOUNDRY OF THE BAYONNE STEEL CASTING CO.

to the crane in the middle bay of the shop, the sand, when mixed, is filled into buckets which are then distributed to the molders by traveling crane. The location of the core department is so convenient to the sand supply that the coremakers have easy access thereto and can help themselves to the mixed piles of core sand. As these departments occupy a corner of the shop diagonally opposite the converters, the sand can be at all times handled without any interference with other work. Two electric traveling cranes of 15 and 30 tons capacity, respectively, and 60-foot span, traverse the center bay of the foundry and are supplemented by six swinging jib cranes equipped with air hoists. These jib cranes are not permanently located in any one position, but can be transferred from one post to another along the center span of the foundry. This is accomplished by fitting each pillar with a set of hinges strong enough to hold the crane and its maximum load, and when any jib has finished its work at any particular post, it is lifted from its sockets by the traveling crane and carried to another part of the shop. Thus, the six jib cranes are always kept busy and are practically equal to one crane on every post. One of these jib cranes is shown at the left, Fig. 3, and consists of an I-beam for the jib as shown, on which a trolley travels, from which an air hoist is suspended. The bay on the east side of the foundry, which is 45 feet wide and about 200 feet long, is served with a 4-ton traveling crane and at one end the cupolas and converters are located.

FIG. 5—THE CHARGING PLATFORM, SHOWING MONO-RAIL CAR WITH A TRAY LOAD OF METAL WHICH IS TO BE CHARGED INTO THE CUPOLA

An industrial track crosses this end of the building, and the castings are loaded onto cars by the traveling cranes and are delivered to the sand blast room. After cleaning and removing the sprues and risers they are chipped with pneumatic tools or ground by swinging grinders, and if bad spots develop on the surface they are removed by an electric welder. After the castings are cleaned they are weighed on scales conveniently located and are then loaded into railroad cars for shipping. For local delivery the castings are shipped by the company's automobile truck and the foundry is so well located that the truck rear of the foundry and is convenient to a side track which extends around the corner of the building shown in Fig. 6, and what appears to be a wing of the building in this illustration is the 45 x 200-foot bay of the main foundry that contains the bench molding and molding machine floors. The narrower portion to which the overhead mono-rail extends is where the melting equipment is installed. Between this building and the railroad track is stored the coke, pig iron, limestone, iron ore, scrap, etc., that is used for making steel. Over the stock piles an I-beam is suspended from a frame work, Fig. 6, and on next track. The crank revolves a three-piece rod by means of two universal joints that operate the switching mechanism. In Fig. 5 is a view of the charging platform, showing the mono-rail car and operator. The platform is loaded with materials ready to be charged into the cupola, all of which are previously brought in by the car. The track terminates in front of the cupola and when charging the iron and coke, is loaded onto the wooden tray, *B*, Fig. 5, which is open at one end and is suspended in such a manner that when raised to the limit by the hoist, the rear end is tipped and the contents are dumped into a

FIG. 6—IRON AND COKE STORAGE YARD WITH MONO-RAIL CAR AND TRACK

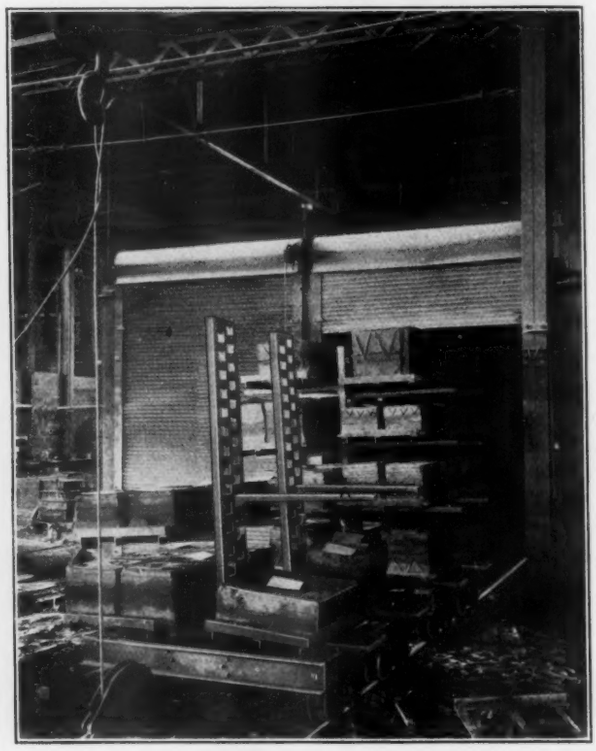


FIG. 7—MOLD DRYING OVENS, SHOWING METHOD OF LOADING THE MOLDS IN THE CAR

can easily make deliveries to several surrounding towns in one day.

The ground plan of the plant, Fig. 9, shows the point at which the sand is delivered at one end of the foundry without interfering with the rest of the work and the raw materials necessary in making the steel enter the plant in a diagonally opposite corner and do not interfere with any other operations. The castings are removed through a door in a third corner and the fourth corner being over low ground is used as a dump for the foundry refuse. By this arrangement the materials travel continuously toward the shipping point without at any time passing over the same ground twice. The stockyard is located at the this I-beam is hung an electric car that is barely large enough to afford the operator a comfortable seat. This car forms part of a 2-ton Sprague electric hoist, *A*, Fig. 5, by means of which the raw materials are transferred from the stock yard to the charging platform of the cupola. The mono-rail curves into the building over the charging platform, the materials being carried in steel dump buckets. The mono-rail track also extends around the corner of the building that is circled by the railroad siding and, therefore, a switch is necessary. In Fig. 6 the car is shown at one end of the switching rail and the operator is turning the crank that switches the opposite end of the rail over to the chute that slides them into the cupola.

Fig. 1 shows the two Tropenas converters, one of which is in operation while the other has been turned down for repairs. The cupola is located between the converters and at one side is the alloy cupola, another view of which is shown in Fig. 8. The alloy charging platform is reached by stairs and the floor above is the charging platform for the large cupola shown in Fig. 5. The mold drying ovens are equipped with double doors and through each doorway is laid a track into the ovens. Two cars are provided for carrying the molds or cores on each track. Thus, the capacity of each oven is four cars, and although at present there are only two

ovens, space has been reserved for further additions to this equipment. A view of one of the cars which possesses some novel features is shown in Fig. 7. The platform is constructed of I-beams and channels and lengthwise the center line are placed two cast steel uprights, each having two rows of square holes so arranged that each row breaks joints with the other and into these holes arms, *A*, Fig. 7, are inserted. These arms, which are adjustable to any height within the capacity of the uprights, carry the shelves for the molds. The shelves are made of iron angles and are distributed to the molders, who place them where convenient on their floors. The molds are placed on the shelves as made and when a shelf is filled it is picked up by the crane and carried to the oven car to be lowered onto a pair of arms set in the upright at any point that will allow clearance of the molds underneath. In this manner the car is built up to the full height of the oven and there is no waste space. At the same time the heat can freely circulate over and around the molds, thus insuring rapid drying.

To handle these cars a loop of wire has been anchored in the floor in the center of each track, and the pulley shown directly in front of the car, Fig. 7, is hooked into the loop. A rope is then passed through the pulley, one end attached to the car and the other is twisted around the hook of the traveling crane, which is then hoisted and the car is rolled out of the oven.

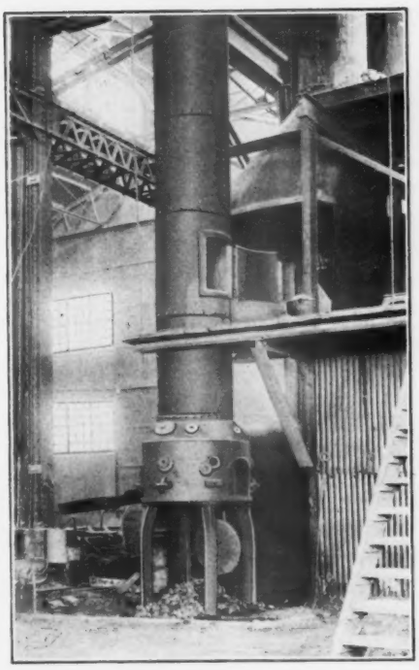


FIG. 8—THE SMALL CUPOLA FOR MELTING FERRO-ALLOYS

A loop is also attached inside the ovens at the extreme end of the track and is also equipped with a pulley through which the wire rope is passed, so that the car is pulled into the oven by the crane in the same manner as it is pulled out. These cars are easily unloaded and the molds conveyed to the casting floors. The shelves are lifted off the core oven cars by cranes. After the removal of a shelf the two supporting arms are removed, which permits of the removal of the next shelf.

Fig. 2 shows the floor for small, green sand molds. At the extreme left, in the background, is shown the room in which the patterns are stored that are in use by the molders and at the left of this room is the foundry foreman's office, and at the right the blacksmith shop. The castings are transported from the foundry to the cleaning room by an industrial railway system, and when the car is unloaded it is filled with sprues, risers, gates and other scrap that accumulates in the cleaning room. This material is then carried to the storage yard. From the stock yard the scrap is later conveyed by the mono-rail car to the charging platform to be remelted. In the cleaning room are two inserted-tooth saws of sufficient capacity to cut off sprues and risers from the largest castings made in the plant. The heavy castings are handled at the saws by a swinging jib crane with a chain hoist, which is located between the two saws. The sand blast room adjoins the cleaning department and the castings are cleaned by the sand blast before shipment. The cleaning room is also equipped with tumbling barrels, an electric welding outfit and swinging grinders and to each post are attached compressed air connections to permit of the use of pneumatic tools in any part of the cleaning room. Two swinging jib cranes equipped with air hoists, similar to those used in the foundry, are also installed in the cleaning room, and in addition an overhead traveling crane commands this entire department.

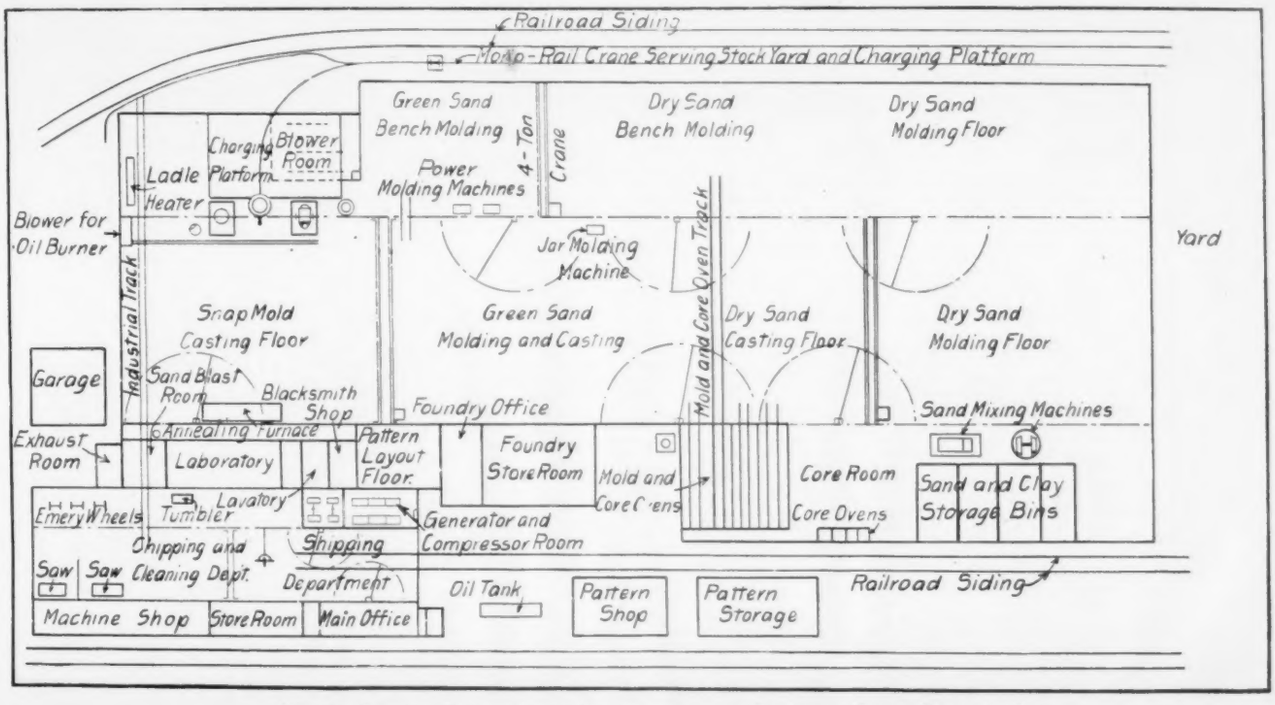


FIG. 9—GROUND PLAN OF THE FOUNDRY OF THE BAYONNE STEEL CASTING CO.

CARBON CONTENT OF MALLEABLE IRON

Discussion of its influence upon the physical properties of malleable castings --- Test heats

By S. B. Chadsey

IT would appear that the historic reserve of the manufacturers of malleables has been but partially abandoned, in spite of the fact that it is generally recognized that greater freedom in the dissemination of knowledge and the exchange of ideas would be to the distinct advantage of the industry, without proving prejudicial to the interests of any organization. The time is past when the fundamental principles of practice were the special stock in trade of a limited number of men, and when fragments of knowledge concerning the construction or operation of furnaces and the physical properties of a satisfactory grade of white iron, were closely guarded as invaluable trade secrets. Much has undoubtedly been accomplished toward the lessening of prejudice against the transfer of information, and much credit is due to those whose publications have contributed toward that end. There remains, however, a great deal that can be done by those who are in touch with the subject through the discussion of the details of practice, such as those which have been of such inestimable advantage to the steel manufacturer, and it is to be hoped that freedom of such discussions may open up, more fully, this very fertile field.

The data herewith submitted have reference in particular to the influence of the carbon content of white iron upon the properties of the annealed metal, and an attempt has been made to indicate the minimum percentage of that element that may be allowed in satisfactory practice when dealing, at least, with medium and light sections.

Carbon Content of Malleable Iron.

There is, indeed, little in print in regard to this particular detail, but it has been claimed that it is unsafe to permit the carbon of the white iron to fall below 2.75 per cent and that it is safer to hold it as nearly as possible to 3 per cent. It has been stated that when the carbon falls below 2.75 per cent, trouble is likely to be experienced in the anneal. Whether by this it is meant that a distinctly different heat treatment in annealing, involving additional expense, is required when dealing with the lower carbon content, or whether it is considered unsafe to treat such metal by any recognized process, we are not aware. In this connection, we may observe that a very fruitful subject for investigation should be that of the annealing temperatures best suited to white irons of varying compositions. It has been the experience of the writer, however, that satisfactory results can be attained on medium and light sections with metal of a carbon content very considerably below 2.75 per cent and that no difficulties need be encountered in the annealing of such metal within the customary temperature limits of the annealing oven.

For purposes of illustration, a number of cases are cited in the accompanying tables, including in each instance the make-up of the charge with its calculated analysis, the analysis of the white iron, the conditions of the anneal and the physical properties of the resultant product. From each heat three sets of test bars were poured, each set consisting of one bar, 1 inch square and 8 inches long, and two round bars having end grips, 1 inch in diameter and 3 inches long, and a central portion ½ inch in diameter and 6 inches long. Drillings for analysis were taken from the square bar, which was also broken to show the structure of the white iron. After annealing the round bars, one was broken by tension and the other was

Heat No. 1.

Seven and one-half tons, 65 per cent pig iron.

Metal charged.	Mixture, pounds.	Silicon, per cent.	Sulphur, per cent.	Phosphorus, per cent.	Manganese, per cent.
Pig iron	400	1.38	0.037	0.21	0.72
Pig iron	150	1.88	0.031	0.13	0.42
Pig iron	600	0.85	0.043	0.21	0.62
Pig iron	150	1.90	0.038	0.11	0 40
Sprues	700	0.85	0.060	0.17	0.25
	2.000				

Calculated analysis of charge.

	Per cent.
Silicon	1.11
Sulphur	0.045
Phosphorus	0.18
Manganese	0.48

Analysis of White Iron.

	Bars. No. 1. Per cent.	No. 2. Per cent.	No. 3. Per cent.
Silicon	0.89	0.88	0.88
Sulphur	0.054	0.059	0.059
Phosphorus ...	0.18	0.18	0.18
Manganese ...	0.34	0.34	0.32
Total carbon..	2.90	2.84	2.70

Fracture—A few graphite spots on bar No. 1; bars Nos. 2 and 3, clear.

Conditions of anneal.—Time of firing, 108 hours; total anneal, 195 hours.

Physical properties of annealed iron.

	Bars. No. 1.	No. 2.	No. 3.
Tensile strength per square inch, pounds..	38,350	39.600	43,060
Elongation, per cent in 4 inches.....	3.91	3.12	5.86
Angle of bending, degrees.....	165	140	170
Fracture	Black.	Black.	Black.

This iron was of relatively poor quality, particularly in the case of bars Nos. 1 and 2. This may have been due to the presence of a small percentage of uncombined carbon.

Heat No. 2.

Seven and one-half tons, 52½ per cent pig iron.

Metal charged.	Mixture, pounds.	Silicon, per cent.	Sulphur, per cent.	Phosphorus, per cent.	Manganese, per cent.
Pig iron	150	1.38	0 037	0.21	0.72
Pig iron	700	1.70	0 035	0.08	0.42
Pig iron	200	1.59	0.024	0.17	0.70
Sprues	925	1.00	0.060	0.155	0.25
Steel	25	0.10	0.080	0.08	0.45
	2,000				

Calculated analysis of charge.

	Per cent.
Silicon	1.42
Sulphur	0.046
Phosphorus	0.133
Manganese	0.34

Analysis of White Iron.

	Bars. No. 1. Per cent.	No. 2. Per cent.	No. 3. Per cent.
Silicon	1.10	1.07	1.07
Sulphur	0.059	0.058	0 058
Phosphorus ...	0.155	0.149	0.155
Manganese ...	0.25	0.25	0.25
Total carbon..	2.66	2.66	2.62

Fracture—All bars good.

Conditions of anneal.—Time of firing, 90 hours; total anneal, 214 hours.

Physical properties of annealed iron.

	Bars. No. 1.	No. 2.	No. 3.
Tensile strength per square inch, pounds..	48,100	47,900	49,880
Elongation, per cent in 4 inches	7.03	5.86	7.03
Angle of bending, degrees	200	135	215
Fracture	Black.	Black.	Black.

General condition of iron—Good.

Heat No. 3.

Seven and one-half tons, 50 per cent pig iron.

Metal charged.	Mixture, pounds.	Silicon, per cent.	Sulphur, per cent.	Phosphorus, per cent.	Manganese, per cent.
Pig iron	400	1.38	0.037	0.21	0.72
Pig iron	150	1.70	0.035	0.08	0.42
Pig iron	300	1.59	0.024	0.17	0.70
Pig iron	150	2.24	0.032	0.14	0.71
Sprues	1,000	1.00	0.06	0.155	0.25
	2,000				

Calculated analysis of charge.

	Per cent.
Silicon	1.31
Sulphur	0.046
Phosphorus	0.161
Manganese	0.45

Analysis of White Iron. Bars.

	No. 1. Per cent.	No. 2. Per cent.	No. 3. Per cent.
Silicon	1.04	1.02	1.04
Sulphur	0.055	0.055	0.059
Phosphorus	0.158	0.158	0.158
Manganese	0.25	0.23	0.23
Total carbon	2.60	2.58	2.54

Fracture—Good.

Conditions of anneal.—Time of firing, 90 hours; total anneal, 214 hours.

Physical properties of annealed iron.

	Bars. No. 1.	No. 2.	No. 3.
Tensile strength per square inch, pounds	45,040	46,060	46,520
Elongation, per cent in 4 inches	6.25	7.03	7.80
Angle of bending, degrees	120	190	180
Fracture	Black.	Black.	Black.

Condition of iron—Good.

Heat No. 4.

Seven and one-half tons, 52½ per cent pig iron.

Metal charged.	Mixture, pounds.	Silicon, per cent.	Sulphur, per cent.	Phosphorus, per cent.	Manganese, per cent.
Pig iron	150	1.38	0.037	0.21	0.72
Pig iron	700	1.70	0.035	0.08	0.42
Pig iron	200	1.59	0.024	.17	0.70
Sprues	925	1.00	0.060	0.155	0.25
Steel	25	0.10	0.080	0.08	0.45
	2,000				

Calculated analysis of charge.

	Per cent.
Silicon	1.32
Sulphur	0.046
Phosphorus	0.133
Manganese	0.34

Analysis of White Iron. Bars.

	No. 1. Per cent.	No. 2. Per cent.	No. 3. Per cent.
Silicon	0.97	0.94	0.92
Sulphur	0.051	0.056	0.056
Phosphorus	0.147	0.145	0.144
Manganese	0.26	0.21	0.21
Total carbon	2.54	2.46	2.36

Fracture—All bars good.

Conditions of anneal.—Time of firing, 99 hours; total anneal, 214 hours.

Physical properties of annealed iron.

	Bars. No. 1.	No. 2.	No. 3.
Tensile strength per square inch, pounds	47,800	45,810	55,230
Elongation, per cent in 4 inches	7.03	6.25	10.55
Angle of bending, degrees	200	160	280
Fracture	Black	Black.	Black.

General condition of iron—Good.

Heat No. 5.

Seven tons, 45 per cent pig iron.

Metal charged.	Mixture, pounds.	Silicon, per cent.	Sulphur, per cent.	Phosphorus, per cent.	Manganese, per cent.
Pig iron	150	1.10	0.061	0.20	0.59
Pig iron	300	1.86	0.035	0.16	0.69
Pig iron	200	1.07	0.029	0.10	0.46
Pig iron	250	1.90	0.038	0.11	0.40
Sprues	1,100	0.88	0.060	0.16	0.25
	2,000				

Calculated analysis of charge.

	Per cent.
Silicon	1.19
Sulphur	0.050
Phosphorus	0.150
Manganese	0.38

Analysis of White Iron. Bars.

	No. 1. Per cent.	No. 2. Per cent.	No. 3. Per cent.
Silicon	0.85	0.85	0 87
Sulphur	0.060	0.060	0.060
Phosphorus	0.149	.....	0.154
Manganese	0.26	0.24	0.23
Total carbon	2.45	....	2.26

Fracture—All bars fair.

Conditions of anneal—Time of firing, 103 hours; total anneal, 194 hours.

Physical properties of annealed iron.

	Bars. No. 1.	No. 2.	No. 3.
Tensile strength per square inch, pounds	43,520	43,520	44,870
Elongation, per cent in 4 inches	9.37	8.6	8.98
Angle of bending, degrees	220	230	230

Condition of iron—Good.

Heat No. 6.

50 per cent pig iron.

Metal charged.	Mixture, pounds.	Silicon, per cent.	Sulphur, per cent.	Phosphorus, per cent.	Manganese, per cent.
Pig iron	300	1.38	0.037	0.21	0.72
Pig iron	300	1.88	0.037	0.13	0.42
Pig iron	100	0.85	0.043	0.21	0.62
Pig iron	300	1.90	0.038	0.11	0.40
Sprues	975	0.85	0.060	0.17	0.25
Steel	25	0.10	0.080	0.08	0.45
	2,000				

Calculated analysis of charge.

	Per cent.
Silicon	1.23
Sulphur	0.048
Phosphorus	0.162
Manganese	0.39

Analysis of White Iron. Bars.

	No. 1. Per cent.	No. 2. Per cent.	No. 3. Per cent.
Silicon	0.91	0.91	0.92
Sulphur	0.069	0.069	0.073
Phosphorus	0.170	0.170	0.175
Manganese	0.21	0.19	0.19
Total carbon	2.50	2.40	2.14

Fracture—Bars Nos. 1 and 2, satisfactory; bar No. 3, too finely crystalline and dull in appearance.

Conditions of anneal—Time of firing, 108 hours; total anneal, 195 hours.

Physical properties of annealed iron.

	Bars. No. 1.	No. 2.	No. 3.
Tensile strength per square inch, pounds	48,020	48,780	50,100
Elongation, per cent in 4 inches	6.25	6.25	5.47
Angle of bending, degrees	190	90	270
Fracture	Black.	Black.	Black.

Condition of iron represented by bar No. 3—Fairly good.

Heat No. 7.

Seven tons, 50 per cent pig iron.

Metal charged.	Mixture, pounds.	Silicon, per cent.	Sulphur, per cent.	Phosphorus, per cent.	Manganese, per cent.
Pig iron	500	1.38	0.037	0.21	0.72
Pig iron	150	1.88	0.031	0.13	0.42
Pig iron	200	0.85	0.043	0.21	0.62
Pig iron	150	1.90	0.038	0.11	0.40
Sprues	975	0.90	0.060	0.17	0.25
Steel	25	0.10	0.080	0.08	0.45
	2,000				

Calculated analysis of charge.

	Per cent.
Silicon	1.15
Sulphur	0.049
Phosphorus	0.175
Manganese	0.43

Analysis of White Iron. Bars.

	No. 1. Per cent.	No. 2. Per cent.	No. 3. Per cent.
Silicon	0.68	0.66	0.57
Sulphur	0.059	0 059	0.062
Phosphorus	0.155	0.163	0.158
Manganese	0.27	0.26	0.21
Total carbon	2.52	2.46	2.08

Fracture—Bars Nos. 1 and 2, good; bar No. 3 was decidedly granular and dull in appearance.

Conditions of anneal—Time of firing, 95 hours; total anneal, 188 hours.

Physical properties of annealed iron.

	Bars. No. 1.	No. 2.	No. 3.
Tensile strength per square inch, pounds	49,070	48,510	51,820
Elongation, per cent in 4 inches	8.98	10.55	6.65
Angle of bending, degrees	190	260	140

Fracture—Bar No. 3 showed a crystalline margin, $\frac{1}{16}$-inch thick.

Heat No. 8.

50 per cent pig iron.

Calculated analysis of charge.

	Per cent.
Silicon	1.21
Sulphur	0.049
Phosphorus	0.157
Manganese	0.38

Analysis of White Iron. Bars.

	No. 1. Per cent.	No. 2. Per cent.	No. 3. Per cent.
Silicon	0.83	0.82	0.82
Sulphur	0.059	0.056	0.063
Phosphorus	0.160	0.160	0.163
Manganese	0.23	0.21	0.19
Total carbon	2.58	2.42	2.04

Physical properties of annealed iron.

	Bars. No. 1.	No. 2.	No. 3.
Tensile strength per square inch, pounds	44,530	45,790	40,860
Elongation, per cent in 4 inches	9.77	10.55	5.08
Angle of bending, degrees	180	180	10

Fracture—Bar No. 3 showed a crystalline margin $\frac{1}{8}$-inch in thickness; it withstood very little bending.

bent under repeated blows until it gave way. In making the bending test one end of the bar was held in a vise and the other end struck moderate blows with a hammer until about half of the estimated bending had taken place. The bar was then reversed in the vise and the other end was struck until facture occurred. The angle of bending was then taken from the change in position of the end portions. This method of treatment resulted in the equivalent of winding the central portion around a pin of about 1¼-inch diameter.

The first set of bars was poured from the first iron from the furnace, the second set from about the middle of the heat and the third set from the last iron out. In many cases the carbon content of the last bars was considerably lower than that of those poured earlier and it is to these that attention is specially directed, as they best illustrate the contention that iron of fairly low carbon content may yield an annealed product of good physical properties. In respect to annealing temperatures it may be stated that they ran from 1,500 to 1,600 degrees Fahr., and averaged about 1,550 degrees.

It will be observed that the best results, based upon the tensile strength, elongation and bending of the annealed bars, were not obtained from the highest carbon irons, such as illustrated in Heat No. 1. It is probable that this fact is to be attributed to the presence of a slight percentage of uncombined carbon. The most satisfactory physical properties were usually found to accompany a carbon content of from 2.25 per cent to 2.35 per cent and excellent material was regularly developed from iron running as low as 2.15 per cent. Below this percentage there was usually a tendency toward a lowering of the ductility of the metal. Examples of this may be seen by referring to the records of elongation and bending in heats No. 7 and No. 8. Although some instances have been met in which fair results were attained with extremely low carbon, as in heat No. 9, bar 3, it has usually been found that when this element fell below 2.15 per cent an unsatisfactory product was turned out, and it is believed that this represents the minimum percentage accompanying satisfactory practice. If it were possible, always, to prevent the reduction of carbon through rapid oxidation during the pour, it would be safe to carry the heats to a fairly low point, say 2.35 per cent, before tapping. But on account of the tendency, more marked in some cases than in others, toward comparatively rapid oxidation as the bath of metal is lowered, it is safer to start pouring at a carbon content of about 2.50 per cent.

Heat No. 9.

50 per cent pig iron.

Calculated analysis of charge.

	Per cent.
Silicon	1.24
Sulphur	0.049
Phosphorus	0.149
Manganese	0.40

Analysis of White Iron.

	Bars. No. 1.	No. 2.	No. 3.
	Per cent.	Per cent.	Per cent.
Silicon	0.92	0 92	0.93
Sulphur	0.062	0.064	0.062
Phosphorus	0.153	0 157	0.160
Manganese	0.24	0 24	0.22
Total carbon	2 44	2 35	1.89

Bar No. 3 showed a very undesirable fracture.

Physical properties of annealed iron.

	Bars. No. 1.	No. 2.	No. 3.
Tensile strength per square inch, pounds	44 100	45,350	47,200
Elongation, per cent in 4 inches	9.77	9.77	5.08
Angle of bending, degrees	250	260	130

Fracture—Bar No. 3 did not have a crystalline margin in the tensile specimen, but when bent, the compression side of the fracture was strongly crystalline.

Conservation of Materials in the Foundry*

By B. D. Fuller

BY the conservation of material in the foundry is meant only the economic handling and use of materials required in foundry practice. The term, *economic handling*, should be used advisedly, as figures will frequently reflect economies which, in reality, do not exist as such. You undoubtedly have met in your experience, the man who is disposed to travel upon his reputation as an economical melter and who can melt 10 pounds of iron with a consumption of 1 pound of coke. Under exceptional conditions, such as very large heats with but one or two cupolas in operation, thus minimizing the bed charges and with scrap of good quality and medium weight, this can be done. Also, in continuous melting, this is not an exceptional record, but I have known of attempts to operate daily at this ratio under ordinary conditions as to size of the heat and the sections of the castings to be poured, when the scrap castings directly traceable to dull iron were more than double the value of the coke saved. Bed charges of 2,000 pounds of coke in a 60-inch cupola with 12,000 pounds of iron, and 500 pounds coke and 8,000 pounds of iron in the subsequent charges, sounds good, but the iron at the spout is liable to be dull and sluggish.

By the application of common sense great economies can be effected in many shops at the cupola, and no further expenditure for equipment is required. The fan or blower should be slightly larger than is absolutely necessary, the blast pipe should be somewhat over-size and should be carried from the blower to the cupola in a direct line, eliminating turns wherever possible. The blast should be introduced into the cupola in volume and should be equally distributed around the circumference of the furnace. Slag continuously and the iron will be melted properly at a minimum cost.

Great economies can also be effected in the use of sand. It is frequently used in a careless and reckless manner in many foundries and wherever this is the case, there should be an awakening to a realization of what this means in dollars and cents. Imagine a shop using 30,000,000 pounds of sand per year where upwards of 100 coremakers are employed and producing both large and small cores. In this shop fire clay was used as a core binder in the proportions of 1 to 12 to 1 to 18 parts of sand. As the sand was largely new, the cores were weak, rotten and close. A large number of cores were broken and scrapped before reaching the molds for which they were intended. According to all indications, the clay binder insured a low-priced core mixture, but was this the case? By introducing a better sand and by the use of a sand-mixing machine, as well as the substitu-

*Read at the monthly meeting of the Pittsburg Foundrymen's Association, March 6.

tion of a core binder for the fire clay in the proportions of from 1 to 40 to 1 to 90, good cores are produced by the use of 60 per cent of old sand and 40 per cent new sand. The breakage of cores is almost entirely eliminated and the number of coremakers, chippers, cleaners and helpers has been greatly reduced. In addition, mechanical sand mixers are now employed in the preparation of the molding sand, the sand for the light work floors being tempered and screened at night. After working along these lines for three years, a saving in sand of 20 per cent per ton of output was effected. On the basis of 30,000,000 pounds of sand per year, the saving of sand amounted to 6 000,000 pounds or 3,000 tons, and at a price of only $1.50 per ton, the cost of sand alone was reduced $4,500 per year.

Ramming the Molds.

Another point that should receive careful consideration involves the proper ramming and safeguarding of the molds to prevent straining or swelling. In the same connection the patterns should receive attention to insure reducing the amount of stock left for finish to the minimum. However, it is an easy matter to run into false economies, as in many cases it is better to extend heads and to leave finishing material on the cope side of deep patterns than to patch or scrap large castings containing dirt and shrink holes, which would not have occurred if extra material had been provided. A saving in the weight of castings can also be effected by proper ramming and this is an item of expense that should not be overlooked. An accurate record should be maintained of the weight of the castings from a certain pattern to ascertain whether they are lighter or heavier this month than last month. A comparison record of the work of any department, if systematically maintained, will gradually result in a marked improvement in the operation of the shop.

Over-Weight Castings.

A problem frequently discussed is the amount of increase in the weight of castings due to foundry causes that should be allowed by the designer, engineer or estimator. Producing castings true to pattern and of the least increased weight is a matter of skill. For certain work, molding machines will insure uniform results, chiefly because the molds are not only properly rammed, but the patterns are withdrawn without being battered by a combination of rapping bar, hammer or sledge and muscle. Patterns, mechanically-drawn, leave the mold in perfect condition. A device that may be applied to patterns other than those made on molding machines that will mechanically draw the patterns out of the sand will materially benefit the foundryman. On deep, heavy castings, made in pits in the floor, it is difficult to estimate how much to allow for extra weight and as a rule, the deeper the pattern and the heavier the design, the greater should be the allowance for extra weight. It is easy for estimators to give weights on straight work, the patterns for which are not cored out to any extent. However, frequently on patterns of complicated design, the actual weights have been fully one-third more than the estimates furnished with the drawings.

Replacing wood with iron flasks will effect great economies in the expenditures for lumber. In the jobbing shop, it is not wise to make iron flasks for every job, nor is it policy to do so on all repetition work of a light character. Wood flasks can be more easily handled than iron flasks and it is possible to increase the output of castings per day with wood flasks in preference to iron. However, in shops where the work is more or less straight, it is an easy matter to get into the habit of making a number of wooden flasks for a job on which great economies could be effected by the adoption of iron flasks. Greater skill and attention is required in hooking, tucking, ramming and securing wooden flasks and when the joint is burnt out, run-outs or crushes frequently result. On the other hand, the iron flask always has a scrap value, while there is no salvage from the wood flask equipment. Imagine a foundry where 20 carpenters were formerly required for a given output and where eight is now an ample force. The output of the foundry, on the other hand, has been materially increased and the lumber bill greatly reduced.

Manganese in Cast Iron

A PAPER read before the Birmingham, Eng., branch of the British Foundrymen's Association, by H. I. Coe, dealt with the effect of manganese on cast iron and the volume changes during cooling. A number of experiments were described, which were made with a view of determining the influence of varying percentages of manganese on cast iron, both in the white and gray condition and in the presence of high phosphorus and sulphur. It was found that manganese added to a pure carbon alloy containing about 3 per cent carbon causes the latter element to remain in the combined condition, the function of the manganese being to keep such an iron white. In the absence of silicon a pure white iron presents difficulty in casting without the occurrence of blowholes, but the addition of 3 to 4 per cent of manganese makes it possible to obtain sand castings. The addition of manganese to a pure washed iron of the following analysis, combined carbon, 3.05 per cent; manganese, 0.035 per cent; silicon, 0.010 per cent; phosphorus, 0.008 per cent, and sulphur, 0.007 per cent, causes a considerable increase in the hardness of cast bars. The hardness readings, 58 and 80, were obtained from the Shore sclerescope for specimens containing 0.03 to 6.3 per cent manganese, respectively. Beyond 6.3 there was a very rapid decrease in hardness, which reaches its lowest point of 52 with the addition of 12.35 per cent manganese, then increases to 67 with 16 per cent manganese. Further additions of manganese again reduce the hardness, which falls to 60 with 18.65 per cent manganese, from which point a gradual increase is noted to 72 with 38.55 per cent of manganese, where the tests were discontinued.

In making these alloys it was found necessary to add an excess of 0.5 per cent of manganese to make up for losses caused by volatilization and slagging of oxide. The surface of the bars containing above 10 per cent manganese was covered with a thick, reddish-brown, metallic skin which, in some cases, could be peeled off the bar. The color of bars containing more than 10 per cent manganese was gray, and all were brittle and intensely hard and could be crushed and passed through a fine sieve. The addition of the first 5 per cent of manganese to the white iron produced no appreciable difference in the brittleness, but further increases up to 13 per cent seemed to give a more brittle bar. Above this amount the bar again appeared stronger until with 19 per cent manganese there was a considerable increase in toughness. With 30 per cent of manganese and over, the metal partook of the nature of a spiegel and was very weak and brittle.

Manganese in the form of a suitable alloy was added to a quantity of hematite iron of the following analysis: Total carbon, 3.71 per cent; graphitic carbon, 3.45 per cent; combined carbon, 0.26 per cent; manganese, 1.07 per cent; silicon, 2.45 per cent; sulphur, 0.028 per cent and phosphorus, 0.053 per cent. The prevailing idea that 3 or 4 per cent of manganese

will convert a gray iron into a white iron was found to be erroneous, an alloy with 8 per cent manganese being definitely gray and with 17.5 per cent manganese distinctly mottled. The addition of manganese to the original 1 per cent manganese pig iron developed a lighter fracture, although with 2.65 per cent manganese there appeared to be a slight darkening of the fracture again. At 6.6 per cent manganese traces of mottling were evident, and this appearance became more definite with the increase of manganese. The bar containing 9.9 per cent manganese was mottled and very crystalline. With over 10 per cent manganese cast iron containing the percentage of silicon given in the analysis of the hematite iron, is readily broken, although it cannot be crushed as easily as the white irons. The effect of manganese on the hardness of gray iron is variable up to 2.65 per cent. With 1.61 per cent manganese, the hardness as given by the Shore sclerescope is 40, at 2.65 per cent manganese, 33. Above 3.45 per cent manganese, there is a steady increase in hardness up to 10.30 per cent, where it reaches 67. With 11.45 per cent manganese there is a drop to 65, after which the hardness rapidly increases until at 17.51 per cent manganese a hardness of 87 is recorded. Gray iron containing up to 3.45 per cent manganese can be readily machined, but with 4.19 per cent manganese it is worked with difficulty. With more than this amount of manganese the alloys were intensely hard, but at the same time retained a considerable amount of toughness.

A New Method of Casting Anvil Blocks

A new method of casting heavy anvil blocks is being practiced in the foundry of the Hooven, Owens & Rentschler Co., Hamilton, O. This concern recently cast a semi-steel anvil, weighing 80,000 pounds, for the Block-Pollak Iron Co., Cincinnati, to replace a cast iron block, which cracked in service. The anvil block shown in Figs. 1 and 2 was cast with a semi-steel, reinforced head. The reinforcement consisted of a net work of twisted steel bars, fitted together so as to counteract the molecular inertia in the varying lines of force under impact. This method of producing anvil blocks is the invention of James A. Murphy, foundry superintendent of this plant.

One of these blocks with a semi-steel, reinforced head, weighing 80,000 pounds, is shown in Figs. 1 and 2. The base of the block is 8 feet 6 inches square and 7½ inches thick, and the body of the block is 5 feet 8 inches by 5 feet 3 inches at the base and tapers to 3 feet 2 inches by 4 feet 6 inches at the top. With a total height of 5 feet 8½ inches above the base, the upper 2 feet 6 inches of the head is cast of semi-steel with steel reinforcement and the lower 3 feet 2½ inches of the block, including the base, is cast of gray iron, but is likewise reinforced with steel bars. The plant is now being equipped to cast these blocks in sizes up to 100 tons in weight.

The blocks are cast in loam, being swept by a straight edge and guides. The mold is built up over a skeleton frame and the anvil block is cast head down. Skeleton guides are fitted at the four corners of the mold and a straight edge is used to sweep the sides of the mold. After being swept, the skeleton frames are withdrawn and intervening spaces are filled with brick and loam. This method of molding has effected great economies over the usual method of using complete patterns and in addition, the time required for doing the work has been greatly reduced. When casting the block shown in Figs. 1 and 2, a large head was used.

FIG. 1—SEMI-STEEL REINFORCED ANVIL BLOCK; WEIGHT, 80,000 POUNDS

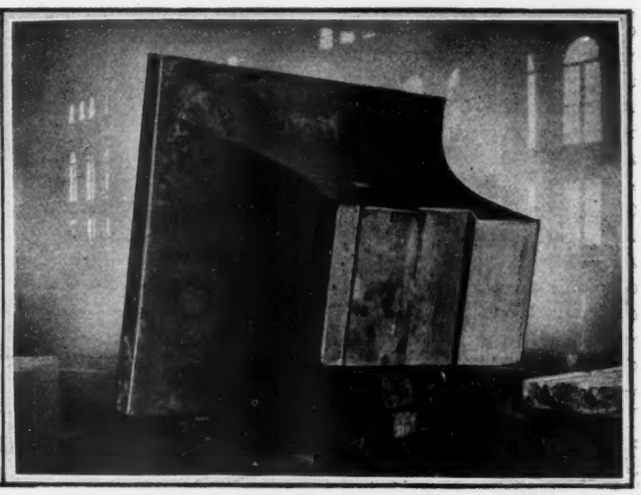


FIG. 2—ANVIL BLOCK TILTED, SHOWING SEMI-STEEL REINFORCED HEAD

Two Rows of Cupola Tuyeres

By W. J. Keep

Question:—We note that several manufacturers are placing two rows of tuyeres in all of the cupolas which they build. Our cupola, which we built, has only one row of tuyeres and we find that foundrymen operating cupolas provided with two rows of tuyeres invariably close the upper row.

Answer:—If the cupola has two rows of tuyeres the foundryman can adapt it to any kind of melting. For continuous melting, or for long continued heats, the upper line of tuyeres will insure the more rapid melting of the metal. In heats quickly run, the blast from the upper row will blow over the iron in the last charge and will chill it unless the blast is shut off before the upper tuyeres are uncovered. The coke must reach above the upper tuyers, which require a deeper bed than when there is only one row of tuyeres. The modern type of tuyere, expanded sideways at its inner end so as to make the tuyeres practically a continuous belt, is of good design and will admit all of the air that is required for melting.

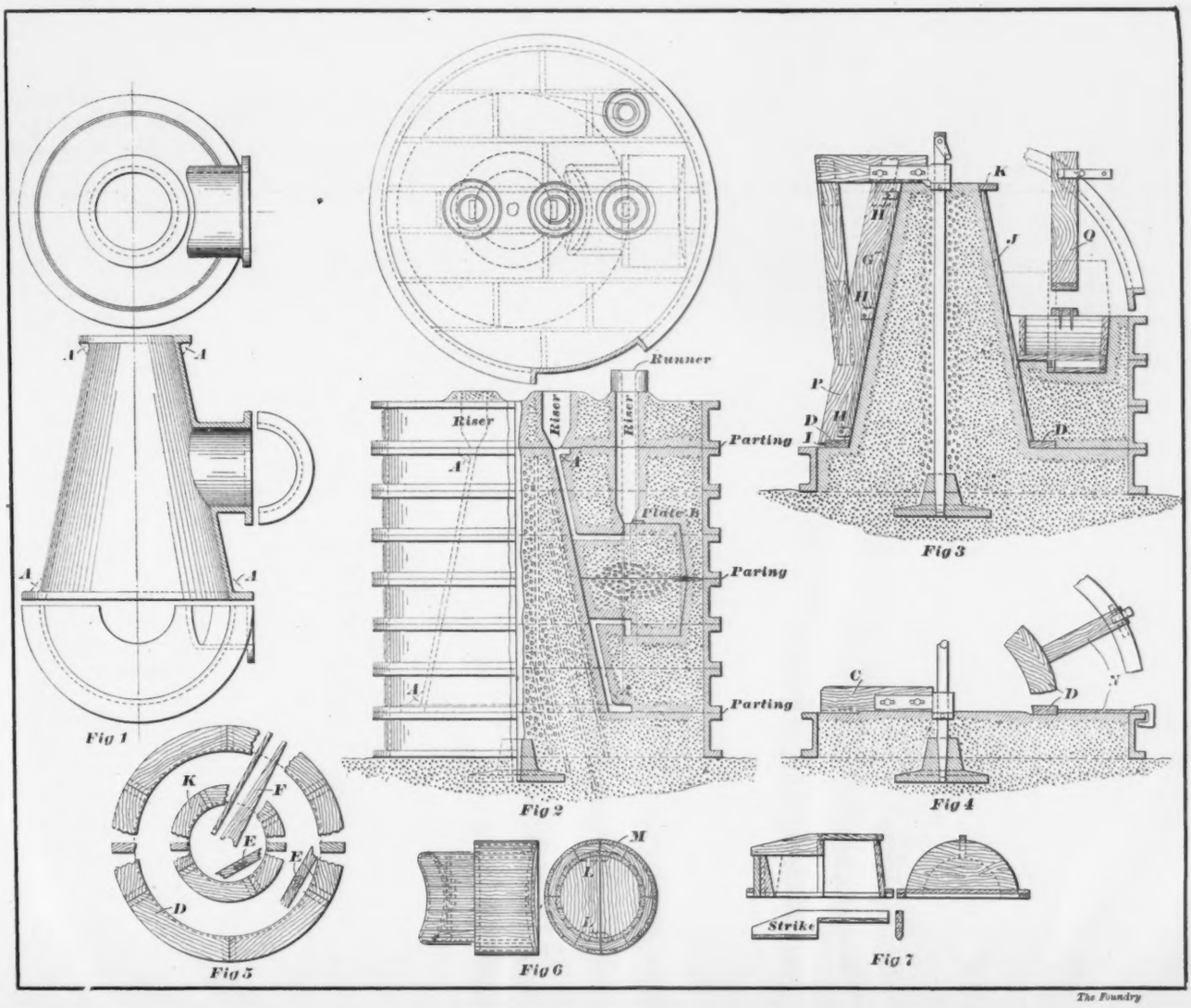
SWEEP-MOLDING A CAST STEEL NOZZLE

The manufacture of this nozzle involved intricate pattern work --- Methods of finding the line of intersection between the branch and body pattern

By H. J. McCaslin

AN ORDER for a cast steel nozzle, of comparatively light section for high pressure work, was recently received and sweep-molding was decided upon as the best method of making this section to insure a perfect casting. The nozzle is illustrated in Fig. 1 and Fig. 2 shows a part cross-section of the mold, part side elevation and plan of the top, showing the arrangement of the runner and risers. It will be noted that the wide end of the nozzle was cast down and this method might be questioned, as molding this section with the wide end up would permit of lifting out the core on a core plate, as is frequently done. This method was adopted so that all chaplets could be eliminated and, furthermore, it was not necessary to handle the core, which could consequently be made softer, thereby obviating one danger of shrinkage cracks. This is a source of trouble frequently occurring at the intersection of two or more members, owing to the increased thickness of the metal at this point. Chills are frequently employed to prevent shrinkage cracks or bracketing is resorted to as shown at *A*, Figs. 1 and 2. These brackets are about ¼ inch in thickness and can be molded in the sand by the use of bracket patterns or they can be cut out of the sand as desired. As they are of a much lighter section than the other metal, they chill first and have a tendency to hold the receding metal to which they are attached. The branch core, it should be noted, is carried out to the full diameter of the flange. By making the core in this way the overhanging position of the core is counter-balanced and, in addition, the flange depression can be more easily washed and finished than if the core were carried out straight. The use of a plate, *B*, Fig. 2, is a further precaution to prevent the raising of the core by the metal. This plate conforms to the diameter of the core and is rammed in the sand over the core print, as shown.

When making this pattern a full-size radial section of the nozzle is laid out, as shown at the right in Fig. 1. As sweeps are used to form the mold their striking edge should, in contour, con-



form to a radial section of that portion of the mold which they form. Guided by this layout the various parts of the pattern and the sweeps, as shown in Figs. 3 and 4, are made and assembled. As sweep *C*, Fig. 4, is employed for striking up the bed upon which to locate the lower flange, *D*, Fig. 4, this is the first device required by the molder. It should be the first of the molding apparatus made by the patternmaker and should be followed by the lower flange, *D*, shown in Fig. 5, which also illustrates the top flange, *K*. For this class of work flanges can be made more quickly from one thickness of material and they will prove just as satisfactory as patterns that are built-up. They are made in segments, held together by tongues, *E*, Fig. 5, which are glued in position. The gage stick, *F*, is also shown in this illustration in the position in which it is used for concentrically locating the flange around the spindle. At the left of the spindle, Fig. 3, is shown sweep, *P*, which forms the conical section of the mold. This sweep, with slight modifications, is used for striking-up the core which forms the interior of the nozzle. This is accomplished by removing the metal thickness strip, *G*, which is attached with cleats, *H*, as shown. The upper end of the sweep is attached to and supported by the spindle, while the lower end of the leg is supported and guided by the shoulder, *I*, which engages the flange, as shown; *J*, Fig. 3, which forms the metal thickness, consists of a series of strips of the same thickness as the casting. These thickness strips support the top flange at the required height and also serve as a protection for the body of sand forming the core. To avoid the production of an over-weight casting, which is liable to occur when the mold is formed by sweeps on account of sticking-off the surface and the straining of the mold, it is advisable to keep down the metal thickness as much as possible. It is also good practice to slightly decrease the metal thickness near the bottom of the mold to overcome the results of straining to which this portion of the mold might be subjected.

In Fig. 6 is shown the pattern for the nozzle branch. The pattern is made in halves and is doweled together as shown at *L*, Fig. 7 shows the arrangement of the core frame for forming this core. When building the branch pattern, which is lagged up over two heads, the head next to the swept portion of the mold is held back a sufficient distance to prevent interference with cutting out this end, so that it will conform to the conical surface which it abuts. No lathe work is done on the branch pattern, the body being rounded with a plane. The filling segments, *M*, are then nailed around the body of the pattern and the larger, or core print diameter, is added. The branch pipe must be made to fit without a trial and the method of finding the line of conjunction or intersection between two bodies of different form may at first appear to be a problem for the drawing room to solve. However, this is a very simple operation, and the principles involved can be applied to a wide range of work. When the body and branch are of equal diameter or cylindrical form the method of finding the line of conjunction is somewhat simplified.

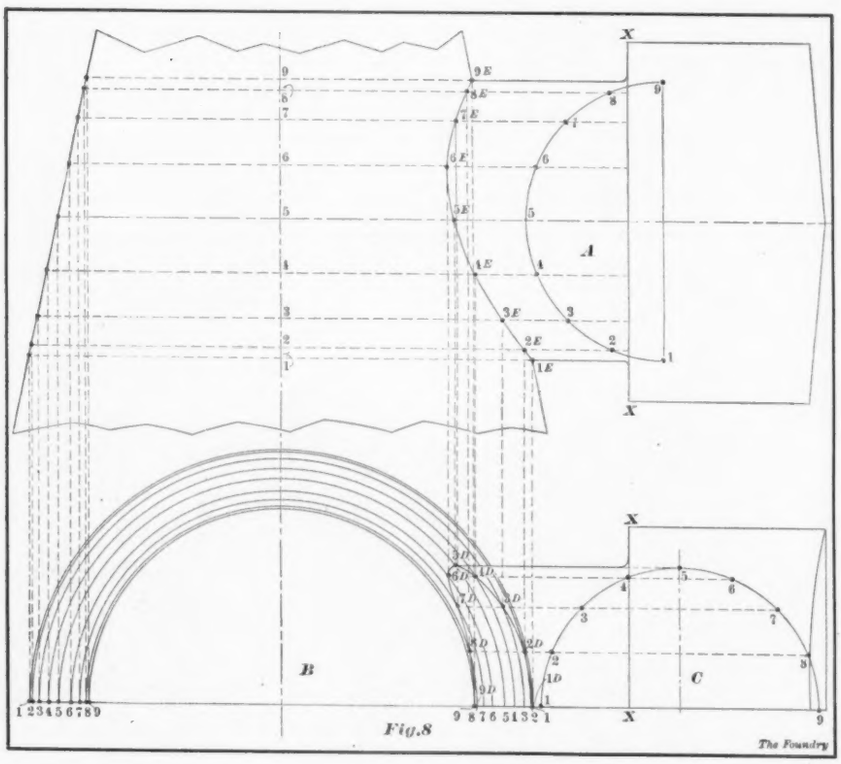


Fig. 8

Finding the Line of Intersection.

In Fig. 8 is shown, in plan and sectional elevation, the method pursued for obtaining the line of intersection between the branch and the body of the nozzle. In the shop this line is developed from the full-size radial section laid out for the sweeps, patterns, etc. The development of this line in Fig. 8, for the sake of clearness, is from the diameter for the purpose of avoiding a confusion of lines which would occur if the radial section were illustrated. A semi-diameter of the branch is first drawn, as shown at *A*, Fig. 8, and its semi-circumference is divided into any number of equal parts and the division points are numbered as illustrated. Through these points lines are drawn parallel with the axes of the branch across the elevation of the body, thus cutting the body into as many sections as the branch, which are correspondingly numbered. A plan of these sections is then drawn as shown at *B*, and these parts are numbered to correspond with the sections of the body. A semi-diameter of the branch is drawn in the position shown at *C*, and its semi-circumference is divided into sections, the various division points being also numbered. Parallel lines are drawn through these points intersecting the sections of the body and these points are numbered *1D*, *2D*, *3D*, etc. A curve drawn through these points of intersection will give the line of conjunction between the branch and the body, as it would appear in a half plan or sectional view. To obtain the line of intersection in the elevation, the lines are projected upward from the points *1D*, *2D*, *3D*, etc., to obtain their intersection with the corresponding sections above, thus obtaining the points *1E*, *2E*, *3E*, etc. A curve drawn through these points gives the line of intersection between the two parts in this view.

Transferring Lines to Branch Pattern.

There are two methods of transferring these lines or points to the branch pattern. One is shown in Fig. 9 and is used when the object is comparatively small. A base line equal to the semi-circumference of the branch perpendiculars, *1 to 9*, is drawn, the dis-

tance from *1 to 9* being divided into the same equal number of parts as the semi-diameter of the branch as shown at *A* and *C*, Fig. 8. These perpendicular lines are numbered to correspond with the sections of *A* and *C*. Take any point on the branch as the base line *1 to 9*, for instance the back of the flange, which for the sake of reference will be indicated as *X*. If the distances *X1E*, *X2E*, *X3E*, etc., are transferred to the corresponding perpendiculars, *1*, *2*, *3*, etc., Fig. 9, the points *1G*, *2G*, *3G*, etc., are obtained. A curve drawn through these points gives one-half of the expanded development of the line of intersection, which, being symmetrical, is all that is required. The drawing is then cut out of the paper on which it has been platted and is wrapped around the branch. The line of conjunction is marked off and the branch is cut off to these lines which will fit the body if the development has been done accurately. The other method is to divide the semi-diameters of each half of the branch into the same number of parts as shown at *A* and *C*, Fig. 8, and to transfer the distances, *X1E*, *X2E*, *X3E*, etc., direct to the branch. Brads are then driven at the points thus obtained and a flexible strip or batten is employed for drawing the connecting curve. By using a narrow blade saw, the protruding ends of the lagging are cut off and this part of the pattern is then ready for the molder.

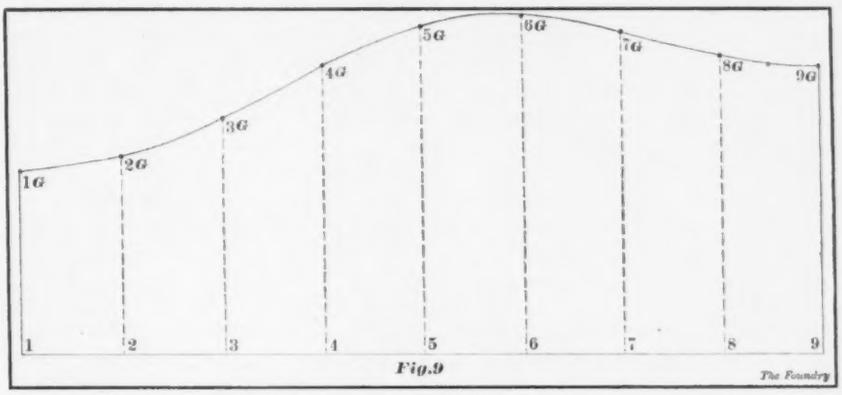


Fig.9

Making the Mold.

After the spindle has been set the first section of the flask is placed in position and the bed is rammed up on which the lower flange, *D*, Figs. 4 and 5, is placed. After the ramming has proceeded to the height of this section of the flask, sweep, *C*, Fig. 4, is attached to the spindle and a bed is struck-off as shown at the left of the spindle in this illustration. Silica facing of considerable thickness is placed below the surface of the bed occupied by the flange. At the right of the spindle the flange, *D*, is shown in position, which is located by the aid of the gage stick, *F*, Fig. 5, and is held in position by three strips clamped to the flask as shown at *M*, Fig. 4. Supported by rods driven into the bed and radiating toward the center, the core, faced with silica, is rammed and built-up around a coke center and is struck-off with a sweep as shown at the left of the spindle, Fig. 3. The preparation of a surface equivalent to the exterior form of the nozzle in size, upon which to ram the cheek, is the next operation. This is accomplished by setting around the core the series of thickness strips, *J*, previously referred to. Using paper as a parting material the strips are set around the core so as to leave intervening spaces approximately 3 or 4 inches wide to be filled in with sand and consequently struck-off with the sweep. The second and third sections of the flask, provided with wing bars, are then set in position over the first flask section and the cheek is then rammed, provision being made for gating into the lower flange depression. When the fourth flask section is set in position the branch pattern must be located and this is easily accomplished by laying off its position on one of the thickness strips, *J*. After the branch pattern is properly located, the drag half of the branch is held in position until rammed by the arrangement shown at *Q*, Fig. 3. The molding is then continued, provision being made for a riser over the branch until the height of the thickness strips is reached, when the top flange, *K*, shown in Fig. 5, is placed in position. The mold is then rammed to the top of the flange, when the parting for the cope is made. After ramming the cope, the cheek portion of the mold is lifted off and the pattern withdrawn. A silica wash is then applied to the surface of the cheek. The thickness strips, *J*, and the intervening thicknesses of sand are then removed from the core and after cutting the gate this part of the mold is ready for finishing. The various parts of the mold are then set over a slow fire and after drying, the mold should be assembled and poured as quickly as possible.

The Molder and Chemical Analysis*

MOST foundrymen know of the advantages to be derived from a knowledge of the analysis of the irons they use, and by means of which a wide variety of iron mixtures can be made. The method advocated, is to have on hand a number of brands of iron of known analysis and various compositions, a quantity of scrap for cheapening the mixture and closing the grain, and then to select such proportions of each brand, making allowance for the oxidation of silicon and manganese, and the increase in sulphur and combined carbon, as will give the desired analysis in the castings.

Assuming that the analyses of the pig irons and scrap are obtainable to a reasonable degree of accuracy, and also that the analysis required to produce the proper mixture of iron for the castings is known, the rest is fairly easy, but unless the foundryman can analyze for himself, or can afford the expense of a chemist, it is difficult to get an analysis of the irons that can be relied upon. Therefore, considerable experience with iron of known composition is necessary to the success of this method.

In a shop making one class of castings continually, when the correct mixture has been obtained, the variations are limited to those of the pig irons used, providing the blast furnace is kept working with regularity and the quality of the coke and flux is kept uniform. As the pig iron made by each furnace is likely to be different from that produced by other plants, certain standards can be fixed only for each particular furnace, and having in mind the variations found in irons of the same brand some

*Abstract of a paper read before the Lancashire (Eng.) branch of the British Foundrymen's Association, by F. Andrew.

means should be provided the molder of acquiring a knowledge of remedying these variations.

To give the molder an opportunity of gaining a better knowledge of cast iron it is not necessary to have a cupola, as a crucible furnace will serve the purpose, the difference in the practice being inconsequential, as the tests would be comparative. For instance, in the cupola, more oxidation and contamination could be expected, and a knowledge of this difference being first obtained, proper allowances could be made. With a crucible furnace having a capacity of from 20 to 40 pounds, castings of special design could be made to give indications of the quality of different mixtures of iron and their relative values for different purposes. For the mixtures, a few brands of pig, and some scrap of known analysis, could be used, each of which would also be tested in the special designs to ascertain whether it would run freely and cast solid. Contraction and chilling tests could be made to ascertain the nature and depth of chill, and in addition the tensile and transverse strengths, with deflection and hardness, could be obtained from bars of the same cast.

Properly Designed Castings.

The majority of molders do not always understand which is a good or a bad design, their knowledge being limited to the class of work to which they have been accustomed. One versed in molding arm pulleys will know that unless he bares the boss when large in proportion to the arms, one or more of the arms is likely to break. If the tread of the rim is narrow and light in section, this is also liable to fracture. Many would give as the reason for the fracture that the heavy boss in shrinking had pulled at the arms, whereas, it is the arms, which, cooling quicker, contract and pull away from the boss.

While the boss remains fluid, this contracting of the arms can take place without any apparent bad effect, but when the boss solidifies, any contraction which occurs will cause more or less tension in the arms, which increases until the normal temperature is reached. If the iron is of a hard nature, an arm may break soon after the solidification of the boss, either near the boss where the metal is not quite hard, or, if the arms have thin parts, the fracture will occur there. With a softer iron, the separation of graphite may have a compensating effect in the contracting arms, which may, as a result, remain whole, or may break while being machined. To overcome these contraction effects, the arms are sometimes curved, the idea being that the curve takes up the contraction, the tendency being for the curve to be reduced. It is quite a common thing for these curved arms to break, but the number will depend on the quality of the iron, other conditions being equal. Therefore, this curve is not as effective as it ought to be, and the amount of contraction taken up by it is very little. If the arm of a pulley which has broken even after being in service is examined it will be found that the two ends will not close together. This space between the fractures is caused by a reduction in the tension of the other arms brought about by the broken arm. If there were no other drawbacks, perhaps straight arms, slightly dished, would be worthy of consideration.

It has been stated that a plate 9 feet in diameter, cast without holes and then cut radially to the center from one edge, would show an opening 1¼ inches wide at the circumference. If this plate were not very thick it would warp, unless uncovered in some parts while still in the mold and red hot. If not uncovered, the opening might be more than 1¼ inches wide. In castings of which such a plate might form a part, this effect might have a serious result, as for instance, in the case of a circular plate with a hole in the center to which a portion of a cylinder is attached with four radial brackets for strengthening purposes. To reduce the effects of crystallization to a minimum in the plate of this casting, it has been suggested that brackets be provided at each of the four sides. If the direction which the crystals will take according to the law that they group themselves with their principal axes perpendicular to the cooling surface, is considered, either the amount taken off in the form of brackets is very small, in which case there is not much effect either way, or if the amount is very large, the shape approaches that of a square with the resulting diagonal lines of weakness between the different sets of crystals. This would require that uncovering be done diagonally or above the brackets. The outside edge of this plate really acts as a radiator between the brackets and while the center may have become black, the boss, and the plate above the brackets, remain red.

Cooling of Cast Iron.

As the rate at which cast iron cools determines the character of the grain, slow cooling producing an open grain and rapid cooling a closer grain, it follows that the outer portions of the plate between the brackets will contract most. This rapid cooling, and, therefore, greater contraction, will account for the tension shown to be present in the large circular plate, previously referred to, when cut. To maintain the shape of a large, circular plate, without holes or slots in the center, either the outer edge must be thicker than the center, or the center must be made to cool as quickly as the outer edge by uncovering at the middle and covering the outer edge with sand and hot metal

Uniform Iron Mixtures

By Paul R. Ramp

WE often hear foundrymen complaining because they cannot obtain as good results as their competitors, although they use the same material in their castings. They sometimes blame their failures to the method of molding, and occasionally this may be true, but local conditions have a great deal to do with the quality of the material in castings, regardless of the iron mixture, as a good mixture is often very disappointing when the cupola is not properly operated. The foundry foreman should not only seek to melt his iron, but he should also purify it at the same time. By this I do not mean to fill each ladle with dope, but to melt in such a manner that it will leave the furnace free from impurities as much as possible. The method of introducing alloys in the ladle is not objectionable, but it cannot be relied upon to restore metal ruined in the cupola to its original strength.

If perfect combustion is attained in the cupola, satisfactory results can be obtained, but in too many cases the heat is either too high or too low, and as a consequence, the higher grades of iron must be used to obtain good results, as their melting process is a destroying process as well. The cupola is often considered an unimportant part of the foundry equipment, as long as the proper material is used, although it may frequently happen that great trouble is experienced with castings, the cause of which is never located, although a care-

ful check of the iron mixture shows it to be what had always proved best for the line of work produced. The real source of the trouble is often obscure, and may have been caused by a damaged tuyere which allowed a leak, or by a variation in the fuel, or the scrap metals used, or even in the steam coal that drives the blower. This may apparently be rather obscure, but when iron is made with a view of getting out all the value there is in it, the margin of safety is very small and it is the little things that often figure as the source of radical changes in the product.

Different Results From the Same Mixtures.

There is no doubt but that the construction and operation of a cupola has a direct bearing on the quality of the metal and that a large quantity of good iron is ruined in melting. One of the great drawbacks to obtaining uniform iron mixtures is the daily variation in the melting conditions at the cupola, and its effect on the quality of the castings. The writer at one time had charge of two foundries. One was equipped with two cupolas and two blower units. The other had three cupolas of a different style which were operated upon a different plan. The cupolas in the new shop were by far the best and furnished a much better material. In one shop, seven cylinders were cast daily. In the other shop, which we will style No. 2, six cylinders were cast daily. The cylinder mixture in shop No. 2 was generally as follows:

	Pounds.
Wharton pig iron	300
Shenandoah pig iron	200
Scrap	1,500

This mixture has a tensile strength of 32,870 pounds per square inch and a shrinkage of 0.28 inch in 2 feet. The chemical analysis follows: Silicon, 1.60 per cent; sulphur, 0.145 per cent; phosphorus, 0.770 per cent, and manganese, 0.351 per cent. This mixture produced first class locomotive cylinders and we were never troubled with cracks or shrinkage when used in No. 2 shop, which was new and was equipped with well designed cupolas. In the other shop, whenever this mixture was melted in the old cupola, every cylinder cracked at the weak points, and large shrinkage holes appeared. In order to produce good cylinders in the old shop, it was necessary to use a more expensive mixture and even then the result was not as satisfactory, which shows how important a factor the cupola is in producing sound castings. A few further instances may be cited. The following mixture for cylinders was used successfully by one company for years:

	Pounds.
Thomas gray iron	850
Thomas No. 2 plain	850
Steel borings	300

When this mixture was tried by another foundryman, the result was very unsatisfactory.

Special Mixture.

A special metal was required on one occasion, and a mixture that resulted in castings having the following analysis were produced:

	Per cent.
Silicon	3.400
Sulphur	0.014
Manganese	0.560
Phosphorus	0.756

This mixture filled all requirements satisfactorily. This metal was then melted in the same cupola with a different blast and tuyere arrangement and the analysis was as follows:

	Per cent.
Silicon	2.00
Sulphur	0.022
Manganese	0.45
Phosphorus	0.78

The castings were rejected on account of being too hard and not sufficiently elastic. The operation of the cupola was accordingly changed, the mixture remaining the same.

Engine Frame Mixture.

A large engine frame was made of the following mixture:

	Pounds.
Charcoal pig iron	600
Iroquois pig iron	300
High silicon pig iron	200
No. 1 scrap	900
	2,000

The analysis of the casting was as follows:

	Per cent.
Silicon	2.50
Manganese	0.35
Graphitic carbon	3.17
Combined carbon	trace
Phosphorus	0.72
Sulphur	0.060

This casting cracked before it was put into service and another was made to replace it, of the same mixture, which turned out satisfactory. This was due to greater care in melting.

The elimination of the sulphur plays an important part in the quality of the iron, and this must be done before the iron leaves the cupola. With a low sulphur, it is possible to run a low silicon, which greatly adds to the strength without materially increasing the shrinkage.

Locomotive Cylinder Mixtures.

The following mixtures are used by several concerns in the manufacture of locomotive cylinders:

Mixture No. 1.

	Pounds.
No. 1 Longdale pig iron	700
Cylinder scrap	600
Hard scrap	500
Steel scrap	200

Tensile strength, 31,990 to 32,810 pounds per square inch.

Mixture No. 2.

	Per cent.
No. 1 Lake Superior pig iron	50
Car wheel centers	25
Selected scrap	25

Tensile strength, 28,000 pounds per square inch.

Mixture No. 3.

	Per cent.
No. 2 Champion pig iron	30
No. 4 Salisbury pig iron	25
Cylinder scrap	35
Car wheel scrap	10

Tensile strength, 24,000 pounds per square inch.

Mixture No. 4.

	Pounds.
No. 2 Croyer pig iron	1,000
No. 2 Crane pig iron	1,000
Chilled wheels	1,500
No. 1 cylinder scrap	1,000

Tensile strength, 21,000 to 23,000 pounds per square inch.

Mixture No. 5.

	Per cent.
Shelby No. 5, pig iron	10
Warwick No. 3, pig iron	25
Niagara No. 2, pig iron	25
Car wheel scrap	20
No. 1 scrap	20

Tensile strength, 21,000 pounds per square inch.

Mixture No. 6.

	Per cent.
Charcoal, Buffalo, pig iron	200
Buffalo No. 2, pig iron	200
Buffalo No. 2 plain, pig iron	600
No. 1 scrap	300
Steel scrap	300
Car wheel scrap	400

Tensile strength, 32,000 to 33,500 pounds per square inch.

Duplicating the Analysis.

In making these mixtures, it is as well to remember that while it is possible to duplicate a mixture, it is not possible to duplicate an analysis in another cupola, unless the melting conditions are the same in both. This is one reason why iron mixtures cannot be made uniform the world over. Another lies in the difference in the design of the castings. If the latter possess a uniform thickness of metal, a mixture very low in silicon and even a little high in sulphur, may be safely used.

Slagging Difficulties

By W. J. Keep

Question:—The inside diameter of our cupola is 36 inches, the tuyeres are 11 inches from the sand bottom and the melting zone is about 11 inches above the tuyeres. We use 600 pounds of coke on the bed, and the succeeding seven charges consist of 1,600 pounds of iron and 160 pounds of coke. Our coke consumption is 1,540 pounds of coke for 10,600 pounds iron. The iron is permitted to run for one hour five minutes. We have charged 30 pounds of limestone on each of the last three and four charges and at times have

increased this to 100 pounds, but find that the cupola will not slag-off properly. The slag hole is just below the tuyeres.

Answer:—The reason for tapping-off the slag is to permit of running long heats and to carry off the slag when it reaches the slag hole to prevent it from running into the wind belt. Your cupola is not melting a sufficient amount of iron to require tapping the slag which does not rise up to the slag hole. It is poor economy to add limestone except to make the slag run out or to insure the bottom dropping clean. A considerable amount of fuel is required to burn the limestone to lime. If your iron is hot and fluid the slag should be given no consideration, unless you wish to melt more than 5 tons per hour.

Skeleton Patterns for Large Work

By Joseph Horner

IN THE largest patterns, even though they are full patterns, that is, not swept-up, much of the detail is of a skeleton-like character. Large bends are usually made in this way as well as condenser and large cylinder patterns. The ribbings are of rough, unplaned timber and are set sufficiently close together to retain sand rammed between them, which is strickled off level with the edges. These edges are cut to the outlines of the castings—semi-circular in the cross-sections of pipes, combinations of curves and flats in condenser bodies, and other shapes on various jobs. Large cylinder molds for reciprocating engines are usually swept in loam, but the steam chest and other attachments are made in wood, with strips, and open spaces to be filled with sand to be rammed against. In this way the expense of timber, which would otherwise be enormous, is lessened and the labor and cost of building-up large, irregular forms in segments or with blocking variously arranged, is saved by the use of strips, to the edges of which only the curved and flat outlines are imparted.

In very large patterns this gives a curiously ribbed appearance to nearly the whole of the work. The molds in many cases cannot be swept with accuracy, chiefly because the flanges, ribs, bosses, branches and various connections could not be bedded in their correct places in the mold without entailing an enormous amount of tackle in the form of plates, with joints, drawbacks, and certainty of very inaccurate results. Although a pattern must be made, its cost is lessened by adopting a skeleton construction in many sections to be filled up with sand and strickled off, and to be rammed against in green or in dried sand mixtures.

Interesting Skeleton Patterns.

Some interesting examples of patterns which have skeleton or framed structures are shown in the accompanying illustration. These were made by the firm of David Brown & Sons, Ltd., Huddersfield, England. This is one of the largest concerns in England engaged in jobbing pattern work. This firm constructed all the high pressure turbine and many other patterns for the Cunard liner, Lusitania. Three of these patterns are shown in Figs. 1, 2 and 3. Fig. 1 represents the top half of a high pressure turbine casing, in which the skeleton structure is seen in some locations both in flat and curved portions. Flanges and strengthening ribs are all solid as in the casting. Fig. 2 shows two patterns, in which the ribbings, building-up, and the strengthening ribs, with loose pieces, etc., are clearly visible. Another pair of casings are shown in Fig. 3, in which the elaborate construction is clearly outlined. Fig. 7 shows the patterns loaded on freight cars ready for shipment. The patterns were made for the firm of John Brown & Co., Ltd., Clydebank, Scotland, builders of the Lusitania.

The Engines.

These patterns, of which the illustrations are representative examples, mark a unique record in marine turbine construction. A few figures relating to the engines for which the castings were used will give an idea of their size. There are six separate engines, two pairs of compound turbines, and two stern turbines. The two compounds, each comprising one high pressure and one low pressure engine, drive the two wing propeller shafts. The two stern turbines drive the two central propeller shafts. The casings for the low pressure turbines measure 32 feet in length and 17 feet 9 inches in depth. The casings of the high pressure turbines measure 28 feet 3 inches in length, and 11 feet 6 inches in depth. The casings for the stern turbines measure 18 feet 3 inches in length and 11 feet 10 inches in depth. The largest casting weighs 35 tons. All the castings were made from special mixtures, remelted into pigs and tested, and the castings were annealed, after cleaning, in an oven heated to from 800 to 900 degrees Fahr., for 24 hours, and cooled slowly in the furnace.

Some idea of the size of these castings may be obtained from the dimensions of the rotors or drums carrying the revolving blades. For instance, the low pressure drum is 140 inches in diameter, with blades ranging from about 8 to 22 inches in length. The drum measures 41 feet 4 inches over its journals and coupling flanges, and weighs over 126 tons. The peripheral speeds range from 100 to 150 feet per second. The engines consume about 850,000 pounds of steam per hour, at 195 pounds pressure per square inch.

Turbine Patterns for a Dreadnought.

Figs. 4, 5, and 6 illustrate turbine patterns for a "Dreadnought" type of battleship. Fig. 4 shows the pattern for the high pressure turbine stern casings. In these there are no open ribbings. The body is strickled by the end portions, which are built up complete, and connected by the longitudinal strengthening ribs corresponding with those on the casting. The various branches are complete pattern parts. A half pattern for the high pressure forward turbine casing is shown in Fig. 5. The ends are built-up in segments, but the middle portions comprise the various branches, etc., attached to ribs around which sand is strickled to be rammed against. Fig. 6 is a half pattern for a casing, which clearly illustrates the ribs around the body and their loose pieces next to the edges, together with sundry branches.

Cylinder Patterns.

Another class of patterns is illustrated in Fig. 8. This represents the high pressure and intermediate pressure cylinders for a large, vertical reciprocating marine engine. Skeleton strips are shown.

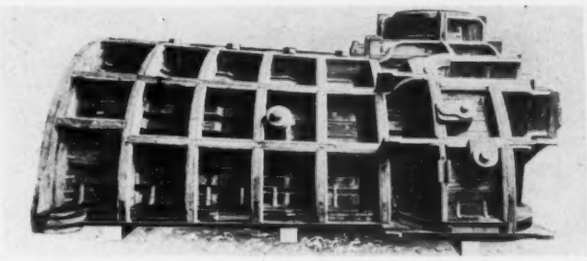


FIG. 1—TOP HALF OF THE HIGH PRESSURE TURBINE CASING PATTERN FOR THE LUSITANIA

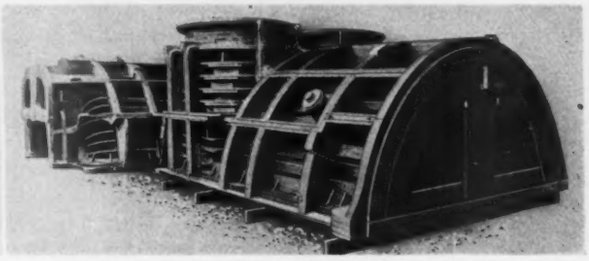


FIG. 2—TWO PATTERNS FOR THE CASINGS OF THE LUSITANIA TURBINES

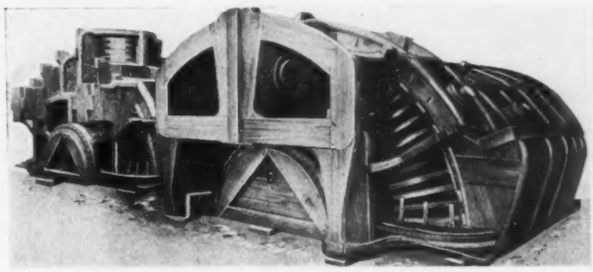


FIG. 3—ANOTHER VIEW OF PATTERNS FOR THE CASINGS OF THE LUSITANIA TURBINES.

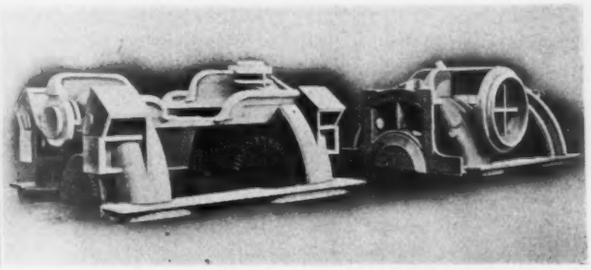


FIG. 4—CASING PATTERNS FOR THE HIGH PRESSURE ASTERN TURBINES FOR A BATTLESHIP OF THE DREADNOUGHT TYPE

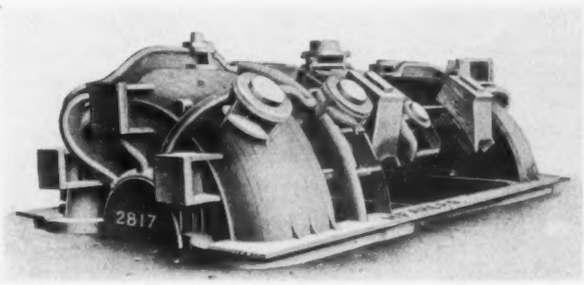


FIG. 5—HALF PATTERN OF A CASING FOR A HIGH PRESSURE TURBINE FOR A BATTLESHIP OF THE DREADNOUGHT TYPE

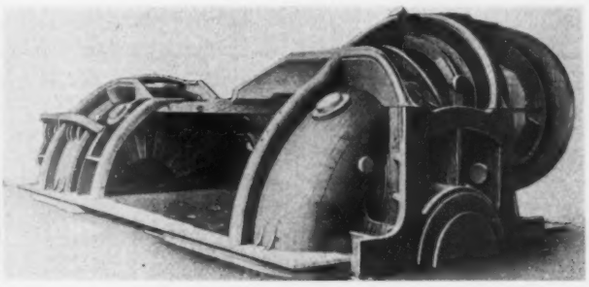


FIG. 6—ANOTHER VIEW OF A HALF PATTERN CASING OF A TURBINE FOR A BATTLESHIP OF THE DREADNOUGHT TYPE

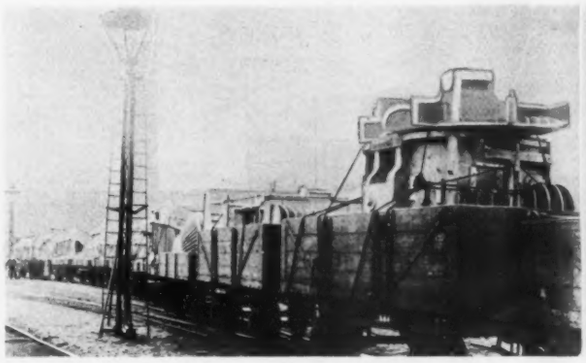


FIG. 7—PATTERNS FOR THE LUSITANIA TURBINES LOADED INTO CARS READY FOR SHIPMENT

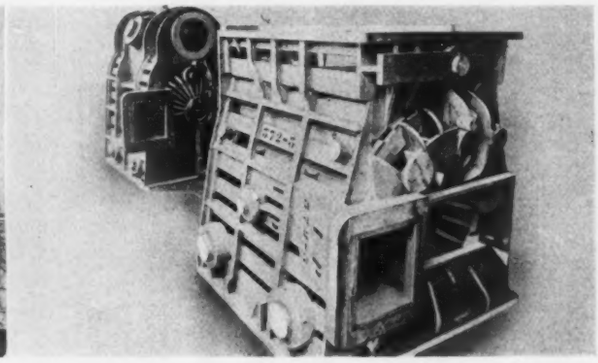


FIG. 8—PATTERNS FOR HIGH PRESSURE AND INTERMEDIATE PRESSURE CYLINDERS FOR A LARGE, VERTICAL RECIPROCATING MARINE ENGINE

TYPICAL MODERN FOUNDRY LAYOUTS--V

General arrangement and equipment of small steel foundries and a pipe shop of 30 tons capacity

THE four previous articles in this series have described successively layouts of gray iron, car wheel, malleable iron and brass foundries, also one combination gray iron and steel foundry. In this article will be presented layouts of two small steel foundries of five and eight tons daily capacity, respectively, and one pipe foundry of 30 tons daily capacity.

In a steel foundry one of the chief features of interest is the furnace and the first problem which usually must be decided in laying out a new plant is the type of furnace that will be employed. Steel castings are made in crucibles, in small Bessemer converters of special design and in basic and acid open-hearth furnaces. Only high grade tool steel or special steels are melted in crucibles and shops engaged in this line of work are usually small. The choice of apparatus for standard steel foundries is thus confined to converters or open-hearth furnaces.

Steel foundry converters are a modified form of those used in making Bessemer steel and are designed to produce steel at a higher temperature than the standard Bessemer converter. They are usually operated in connection with a cupola, from which the hot metal is obtained. Few steel foundries of large capacity use converters, for reasons which will be presented later.

Open-hearth furnaces for steel foundries are similar in general design to those in steelmaking plants except that the units are usually smaller. The furnace is built of refractory brick, the dimensions varying with the capacity. The hearth may be lined with silica sand or magnesite and the charge is a mixture of pig iron and steel scrap. The fuel may be either producer gas, natural gas or oil.

The converter process requires a special class of pig iron, which must be very low in sulphur and phosphorus. Steel scrap may be used, but it must also be low in sulphur and phosphorus, since these elements are not removed in the Bessemer process. The pig iron or scrap is, therefore, necessarily costly in comparison with open-hearth stock and, on account of the growing scarcity of Bessemer ores, is becoming less and less available in the market. Bessemer steel castings are, therefore, more costly than open-hearth castings. The great advantage of the Bessemer converter is that it is convenient to use, particularly in small units, and that the first cost is comparatively low. Small converter plants are so very cheap, often costing less than $5,000 for the steelmaking equipment alone, that a great many iron foundries in this country are installing them as an adjunct to their gray iron department, that they may be able to make steel castings as required. The amount of capital tied up is small and there is no great expense incurred in starting and stopping the

The layouts, shown herewith, were designed by the Whiting Foundry Equipment Co., Harvey, Ill.

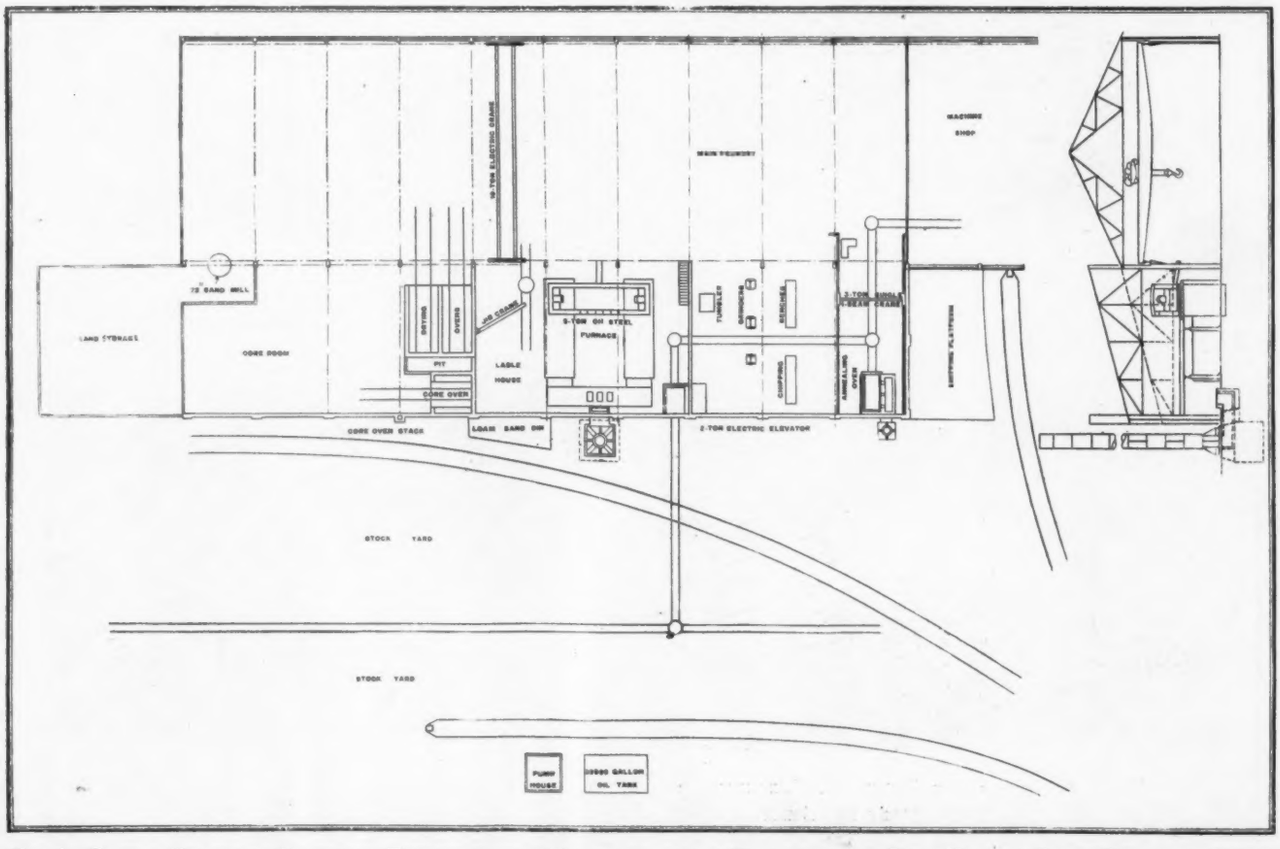


FIG. 1—GROUND PLAN AND SECTIONAL ELEVATION OF A FOUNDRY FOR THE PRODUCTION OF OPEN-HEARTH STEEL CASTINGS; DAILY CAPACITY, FIVE TONS

converter, as is the case with open-hearth furnaces. The majority of the converters used for making steel are of the Tropenas type, in which the blast enters the vessel from several tuyeres on the side and the converter is tipped in such a manner that the blast is deflected onto the top of the bath. The impurities are oxidized in the same manner as in the regular Bessemer process except that the action is not quite so rapid.

In laying out a Bessemer steel foundry it is customary to place the converter close to the cupola in order that the hot metal may be conveniently transferred to it, either by means of a spout leading directly into the converter or with the aid of a ladle and bracket crane.

The bulk of the steel castings produced in this country is made in open-hearth furnaces which may be conducted with either basic or acid hearths. The acid open-hearth process, like the converter process, requires special pig iron and scrap. The pig iron need not be as high in silicon, but is subject to the same limits in regard to sulphur and phosphorus. The basic process has a wider scope in the choice of stock, but is limited principally as to silicon. The ores from which acid pig iron are made are gradually becoming more scarce, while ores for producing basic pig iron are comparatively plentiful. The ore situation is gradually and permanently making the basic process general in steel foundries in this country. "This", as stated by Bradley Stoughton, "is in spite of the fact that basic steel has very serious disadvantages, the chief among which are the amount of oxygen it contains at the end of the process and the difficulty of adding the desired amount of silicon with the recarburizer, both of which conditions increase the liability to blow-holes, which are especially objectionable in castings, since there is no opportunity of their being welded up, and castings may have to be discarded on account of them after a good deal of machine

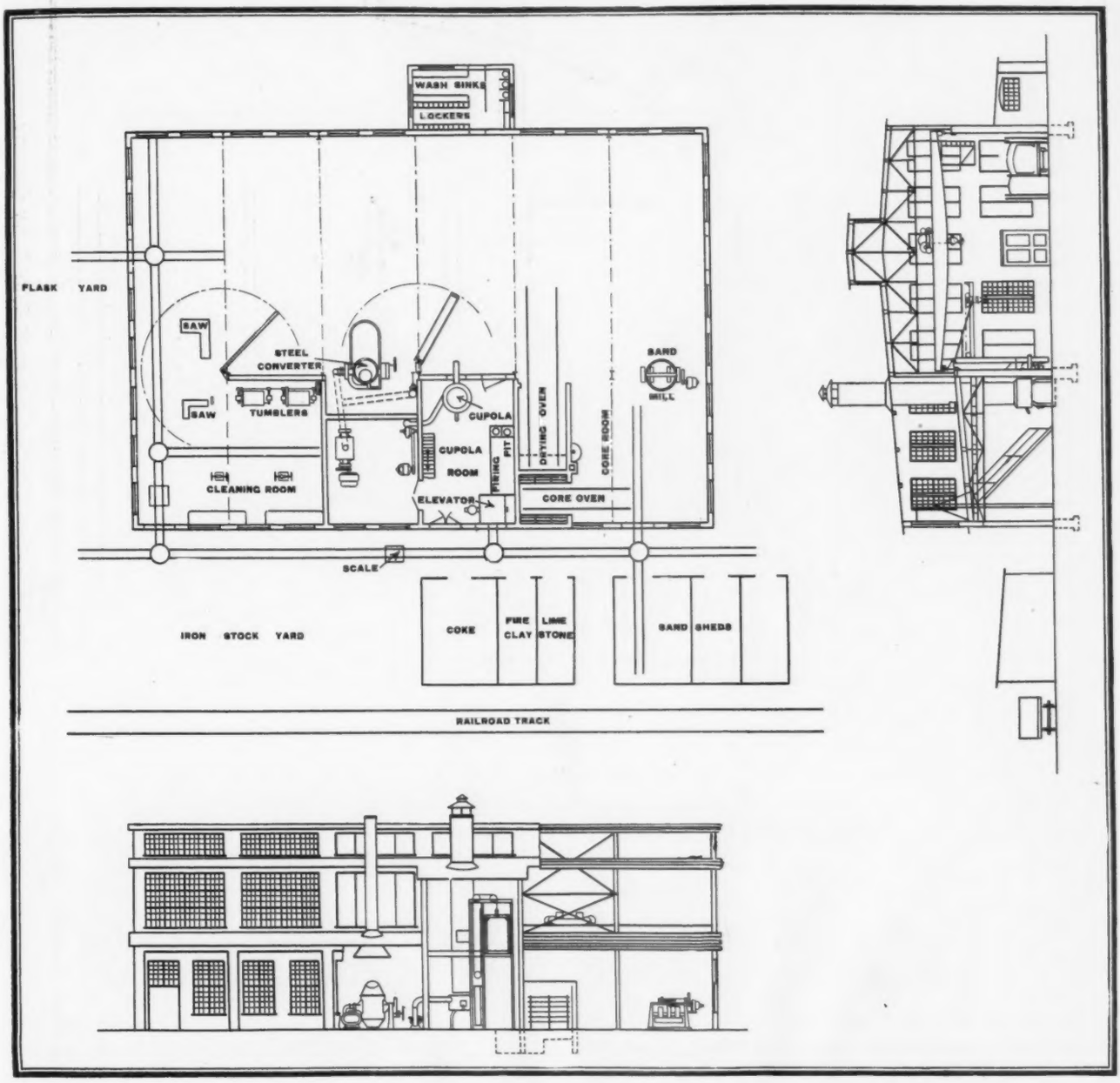


FIG. 2—GROUND PLAN, SIDE ELEVATION AND CROSS-SECTION OF A CONVERTER STEEL CASTING FOUNDRY OF EIGHT TONS DAILY CAPACITY

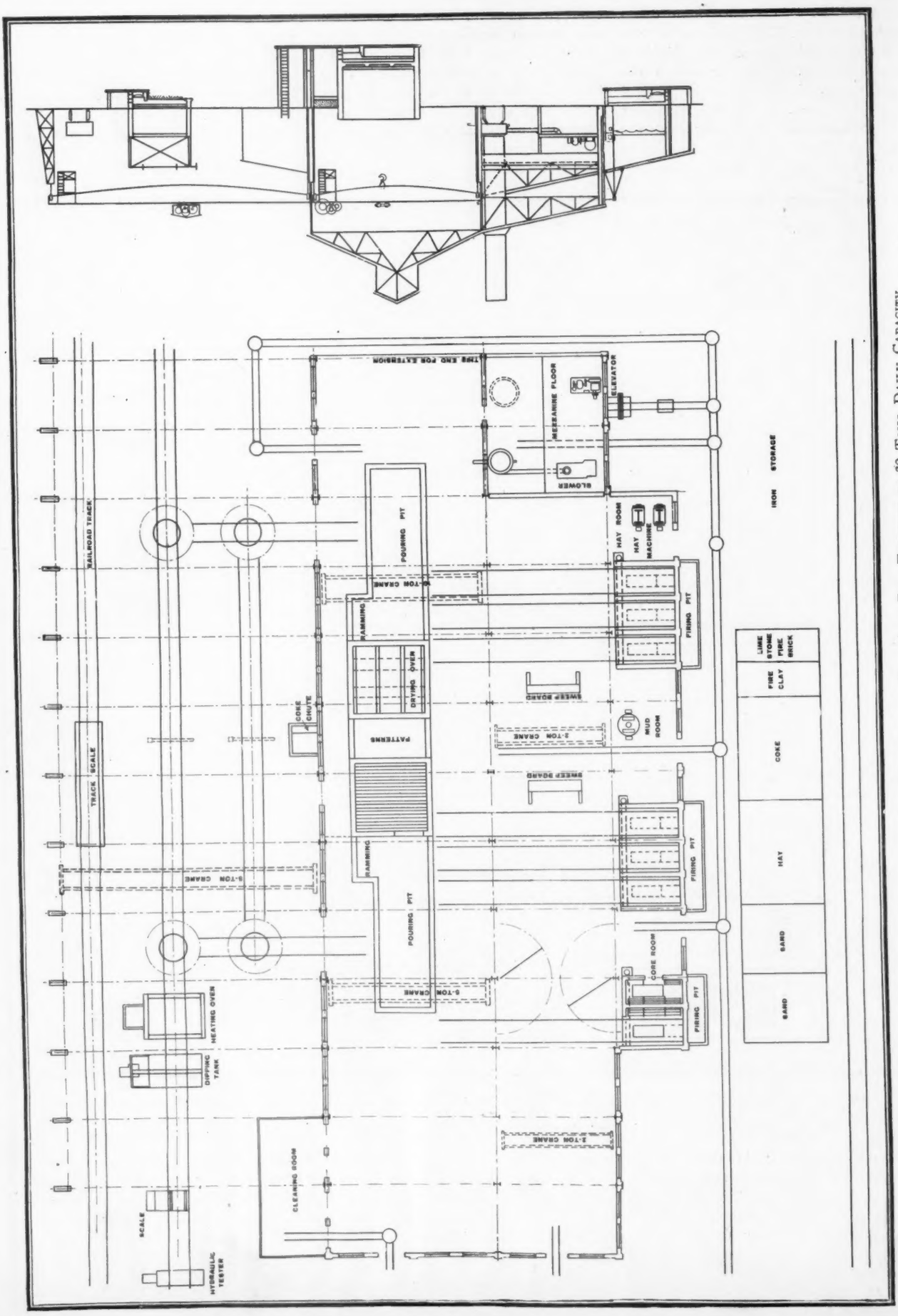


FIG. 3—GROUND PLAN AND CROSS-SECTION OF A CAST IRON PIPE FOUNDRY OF 30 TONS DAILY CAPACITY

work has been done." On this account the acid open-hearth process has long held the predominant position in the steel casting industry. In fact, this is the only place where the acid open-hearth process now finds important employment.

A Five-Ton Open-Hearth Shop.

The five-ton open-hearth steel foundry, illustrated in Fig. 1, is housed in a steel frame building, consisting of a main bay, 195 feet long and 61 feet wide, surmounted by a monitor roof, and a side bay of the same length and 40 feet wide. The main foundry has a molding floor area of 11,895 square feet. The plant is equipped with a 5-ton open-hearth furnace, centrally located in the side bay, the regenerative chambers being long and narrow and placed at either end of the furnace at right angles with the main axis of the hearth.

Three core ovens are installed in the core room at one end of the side bay. The dimensions of these ovens are as follows: Two, 18 x 8 x 6 feet, and one, 10 x 10 x 7 feet, each oven being coke-fired and provided with a car and racks.

This shop is equipped with a small annealing oven with a hearth 4 feet 6 inches wide and 10 feet long, as shown on the plan in Fig. 1. The cleaning room, situated in the side bay at the right of the furnace, is equipped with standard Whiting tumblers and three double emery grinders. Two chipping benches are also installed.

Attention is called to the ample sand storage yard at one end of the building. This yard is 40 feet square and is flanked on one side by a railroad spur. In the passage between the sand storage bins and the foundry is a 72-inch sand mill which is employed to grind and prepare the sand for molding.

The molding floor is served by a 10-ton Whiting electric traveling crane, equipped with a 5-ton auxiliary hoist, the span of the crane being 60 feet. A 3-ton jib crane is also installed in the side bay near the furnace and a 24-inch industrial railway reaches all parts of the shop and yard.

Concrete Steel Casting Foundry.

The layout of a 6 to 8-ton plant, equipped with a side,blow converter, is shown in Fig. 2. This plant is provided with a cupola 42 inches in diameter inside of lining for melting the stock preparatory to charging in the converter. The cupola is enclosed and the firing pits of the core and drying ovens are located in the cupola room. The steel converter is situated at one side of the molding floor at the left of the cupola and as shown in the illustration, the cupola and converter are served by a bracket crane having a radius of 16 feet.

The molding floor of this shop is 120 feet long and 50 feet wide. The side bay containing the cupola room, blower room, cleaning room, core ovens, etc., is 120 x 30 feet. A motor-driven sand mill is installed. The plant is provided with a large drying oven, 18 feet long, 10 feet wide and 6 feet high, and with a standard core oven, 10 x 10 x 7 feet, equipped with a car. The track from the drying oven is laid out into the molding floor so the dried molds may be handled by the main traveling crane.

Aside from the fact that this shop is fitted with a steel converter it differs very little from an ordinary gray iron foundry of eight tons capacity.

Cast Iron Pipe Foundry.

Fig. 3 shows a cast iron pipe foundry of 30 tons daily capacity. This type of foundry is very important since the amount of cast iron pipe annually produced in the United States is between 500,000 and 800,000 tons. A number of continuous systems have been devised for manufacturing cast iron pipe and one of the most modern of these was described in the January issue of THE FOUNDRY. The plant, illustrated herewith, is an ordinary cast iron pipe shop in which the work is largely done by hand. The building is 260 feet long and 85 feet wide, divided into two bays. The main bay is served by one 10-ton and one 5-ton traveling crane; each crane has a span of 50 feet and both run on the same track. The side bay is served by two 2-ton cranes, each having a span of 30 feet.

As shown in Fig. 3, the core department is equipped with mud mills and hay rope machines, since the cast iron pipe cores are formed by rolling mud on a foundation of hay wound over a core bar. The core department is provided with eight ovens, each 9 feet wide and 17 feet long. The tracks from the ovens lead to the edge of the ramming pit and the cores are placed in the molds by means of the traveling cranes.

The ramming pit is equipped with two drying ovens, which are fired by gas, each oven being 20 feet square. Between the ovens is a space, 12 x 20 feet, for storing patterns. The molds are rammed and poured at two points in the pit, as shown on the plan, Fig. 3.

The foundry yard back of the molding room is served by a 5-ton electric traveling yard crane having a span of 75 feet. One rail of the yard crane runway is supported by the wall columns of the building and the other by independent structural steel towers. The yard is provided with skidways extending in to the edge of the ramming pit, in which the finished pipes are rolled to the cleaning shed and also to the heating and dipping plant. The several skidways are connected by four turntables, as shown in Fig. 3. The foundry yard is also traversed by a railroad spur track in which are installed standard track scales for weighing shipments of pipe.

The foundry supplies and pig iron are stored in the yard back of the coremaking department, the sand, hay, coke, fire clay and limestone being cared for under cover. No provision is made for handling or storing scrap since cast iron pipe is usually made with pig iron alone.

Coating Department.

As has been suggested, the last operation on the pipe before it is tested is to coat it for protection against corrosion. The coating used is generally melted asphaltum, pitch or tar. There is also a paint made by distilling off the creosote and other volatile components of tar until the solid asphaltum is left. This is then redissolved in two of the distillates, neither of which will attack iron, and thus a paint is obtained which is said to be practically tar without any of its harmful constituents. It forms a very lasting coating which does not crack after years of exposure and it is claimed that it will not disintegrate from the action of the sun. Compressed air hoists are used in handling the pipe in the dipping tank while the tar or pitch is kept hot by a gas or coke fire.

"American Vanadium Facts" is the title of a new eight-page publication, issued by the American Vanadium Co., Frick building, Pittsburg. The leading article, entitled "What is Vanadium," briefly discusses the physical properties of this metal. Another article, entitled "Vanadium Steel Forgings," discusses the use of ferro-vanadium as an alloy in metal to be forged, and other articles presented treat of the use of vanadium in the manufacture of steel castings. The publication is well illustrated and contains many interesting facts regarding the use of ferro-vanadium in both iron and steel.

A MODERN CAR WORKS' STEEL FOUNDRY

Description of the new plant of the Bettendorf Axle Co. --- The molding and pouring is done in separate departments --- Continuous annealing furnaces and core ovens

IN RECENT years a number of large foundries have been built in various parts of the country for the purpose of manufacturing cast steel car parts and railway specialties. While in a certain sense these shops are highly specialized, yet the equipment and principles employed are such that they may be applied to a great many other lines of foundry work with profit. A modern railway specialty foundry is, therefore, of considerable interest to the general foundrymen. One of the latest shops of this character has been built by the Bettendorf Axle Co., in connection with its new car building plant at Bettendorf, near Davenport, Iowa. This foundry is so arranged that the molds are made in one room and are poured and shaken-out in another; thus the molders' time is not interrupted and the output per man is materially increased. This arrangement is unusual for a foundry producing heavy steel castings weighing 200 pounds or more each, but it has proved very successful in operation.

The Bettendorf foundry is a red brick, steel frame structure, covering a plot of ground, 550 x 440 feet. The bays containing the open-hearth furnaces and material bins are each 70 x 440 feet and the two molding bays, each 260 x 50 feet, parallel the furnace bays. At right angles to the axis of the furnace and molding bays, on the south side of the plant, is the metal pattern and machine shop bay, 200 x 50 feet, while on the north side, parallel to this bay, are the sand room, 240 x 50 feet, and the two annealing, cleaning and chipping rooms, each 400 x 50 feet. The foundry building has a floor space of 160,000 square feet.

Practically all the molding is done on machines. As shown in Fig. 3, several large sand bins, filled by an overhead belt conveyor, are situated between the two molding bays, the bins being provided with chutes on both sides, delivering sand into each molding room. The molding machines are located at the side of the sand bins. As fast as the molds are set up, they are placed on small trucks by the traveling cranes and wheeled into the furnace bay, where they are distributed in rows for convenience in pouring. After being poured, the molds are picked up by cranes and shaken out along the west wall of the room, opposite the furnaces. The sand goes into hoppers, from which it is deposited on a belt conveyor that delivers it back to the mixers, Fig. 4. The finished castings are carried to the north end of the shop and from this point they pass successively through the sand blast, annealing furnaces and straightening press to the finishing and chipping racks at the west end of the cleaning and shipping bay. New molding sand is stored in bins at the west end of the sand room and a belt conveyor leads from the bins to the mixers. The necessary cores are baked in continuous ovens, situated in the west molding bay, convenient to the points where the molds are set up. The principle products of the shop are cast steel truck frames, bolsters and draft sills for railway freight cars. All of these castings are characterized by irregular shapes, large surfaces and comparatively light sections.

Two 25-ton, oil-burning, basic open-

FIG. 1—POURING FLOOR OF THE BETTENDORF AXLE CO.'S STEEL FOUNDRY, SHOWING THE TAPPING SIDE OF THE OPEN-HEARTH FURNACES

FIG. 2—OPEN-HEARTH FURNACE CHARGING PLATFORM

hearth furnaces have been installed in the southeast corner of the furnace bay, space being left for a third, which will be built when it becomes necessary to increase the output of the plant. Each furnace has a 10 x 25-foot magnesite hearth; the regenerators are underneath on either end, their long axes being at right angles to the main axis of the hearth. The furnaces are unusually solid in construction, the framing, buck stays, door plates, etc., being extra heavy to avoid warping. The doors and door frames are water-cooled. The advantages of this construction and of the oil-burning apparatus are evident in the comparatively few repairs, which have been required; one of the furnaces ran 420 heats, after which it was voluntarily taken down.

One oil burner is placed in each end of the furnace and being water-cooled, remains there permanently. This permits solid connections and simplifies the piping. The burner consists simply of three concentric pipes, about 7 feet long, the outer one being approximately 6 inches in diameter. The inner pipe carries oil under a pressure of about 100 pounds per square inch; the middle pipe carries air under 80 to 90 pounds pressure and the outer one water, which is kept constantly circulating. The furnace is designed so it may be operated with producer gas at any time.

The charging floor, Fig. 2, is unusually large and its construction is noteworthy. Heavy I-beam columns, supported by concrete footings, carry the floor proper, which consists of a sheet of concrete, about 5 inches thick, laid over steel plates. The rails for the charging cars and charging machine are embedded in the concrete. A Morgan,

FIG. 3—STRIPPING PLATE MOLDING MACHINES FOR MOLDING CAR BOLSTERS

FIG. 4—THE SAND-PREPARING AND MIXING PLANT

four-motor charging machine is installed.

North of the charging floor are four large concrete pig iron and scrap bins with a capacity of 7,000 cubic feet, or about 1,000 tons each. The bulk of the scrap and pig iron in stock is thus kept under cover at a point close to the furnaces. The bins are each 20 x 30 feet, inside dimensions, and 10 feet deep. A railroad track extends along one side for bringing in material, while a five-ton traveling crane serves the bins and charging floor. A 500-ton Bettendorf hydraulic scrap shear is installed in the furnace bay near the storage bins for shearing rails and heavy scrap. This shear has proved very efficient and economical. Gates, risers and defective castings are loaded directly into charging cars in the pouring bay and by a transfer track are shifted to the charging floor, ready to go into the furnaces.

The oil tanks, of 36,000 gallons capacity, are set in concrete basins with insulated roofs. The tanks are each equipped with two domes to permit two cars of oil to be unloaded at once. The brick furnace stacks are 120 feet high. All-brick stacks for open-hearth furnaces are somewhat of an innovation, the usual practice being to erect steel stacks with brick linings.

Sand-Handling Equipment.

The sand-mixing and sand-conveying equipment is illustrated in Fig. 4. The apparatus handles about 300 tons of sand per day. The machines are centrally located at the north end of the molding rooms and consist of two 25-ton continuous heavy sand-mixers and two 15-ton facing sand mills. Three belt conveyors connect the mixers with various parts of the shop; one leads to the sand bins and brings in new molding sand, another extends into the pouring bay, while the third carries prepared sand to the bins near the molding machines. As previously stated, the molds are shaken-out along the west wall of the pouring bay, the sand going into hoppers, underneath which runs a belt conveyor, carrying it to the mixing machines. The hoppers are grated and are large enough to permit the sand to cool before being returned to the mixer. The sand room contains five concrete bins, providing sufficient storage capacity for a winter's supply of sand. The bins are equipped with steam coils for drying the sand. A five-ton, 48-foot span electric traveling crane, provided with a ½-yard grab bucket, is used to unload the sand from cars and deposit it in the bins. The bins for prepared sand, located between the molding rooms, are large wooden structures, provided with suitable discharging chutes on both sides. The belt conveyor from the mixing machines runs over the top and is provided with two self-propelling discharging trippers.

FIG. 5—STEEL CASTING CLEANING DEPARTMENT

Stripping Plate Molding Machines.

The molds are made on stripping plate machines, shown in Fig. 3. They are used in pairs, one machine making drags and the other, copes. Five laborers are employed on each pair of machines, their output being about 50 truck frame molds per day. A five-ton traveling crane, provided with a yoke and chain slings of special design, is used to handle the flasks to and from the machines and to carry the molds about the floor. The flasks are all-steel. The sides are commercial rolled channels and the ends are castings provided with trunnions, by means of which the boxes are picked up in the slings suspended from the crane. The copes are patched and small cores set while suspended from the crane, and the drags are rolled over while in the air, immediately after they are lifted off the molding machines. When the cope is placed on the drag, the mold is not opened again until it is shaken-out. The molders work continuously, the pouring, shaking-out, etc., being done by a separate gang of men.

Pouring Floor.

Between the molding and pouring bays is a wall, pierced by six large doors, through which the molds are conveyed on transfer trucks to the pouring floor, Fig. 1, in front of the furnaces. In spite of the rather long transfer and double crane handling, to which each mold is subjected, losses have been remarkably light and this method has the great advantage of preventing a loss of molding time on account of pouring and shaking-out.

The arrangements which have been made to separate the molding and pouring, devoting separate floors to each process, is one of the most original and commendable features in the Bettendorf foundry. It is true that this system requires considerable more floor space than the ordinary method, and an additional investment in buildings, but the time saved and increased production realized from being able to keep the molders busy all day without interrup-

tion, pays splendid interest and profits on the slight additional investment. In the ordinary steel foundry, where the molds are made, poured and shaken-out on the same floor, there must be, even with the most careful management, considerable loss of molding time daily whenever a heat is taken off.

Crane Equipment.

In order to economically transport the heavy molds, a very complete crane equipment has been installed. The pouring bay is equipped with two five-ton, 70-foot span electric traveling cranes for handling molds and castings, one three-ton electric traveling wall crane with a 20-foot overhang, a 35-ton, 70-foot span ladle crane with a five-ton auxiliary hoist and two three-ton jib cranes for handling furnace spouts. The two molding rooms are equipped with two five-ton, 48-foot span traveling cranes and several small jib cranes.

At the north end of the pouring bay the gates and risers are knocked off the castings and rough chipping is done. The castings are then sand-blasted and taken to the annealing furnaces.

Annealing Furnaces.

Two annealing furnaces, centrally located at the east end of the chipping bays, are installed. The design of the furnaces is new and original and they are operated continuously. The process can be regulated according to the thickness of the castings, both the time of annealing and the temperature being variable and controlled practically automatically. The castings do not come into direct contact with the flame in the furnaces and are annealed by a soaking heat.

Continuous operation is obtained in the following manner. A track is laid through each furnace, on which run small trucks, or cars, carrying the castings. The trucks are shoved through the furnace by the action of a hydraulic cylinder placed at the front end, each car in the line communicating the force to the one ahead of it. Underneath is a tunnel, through which the cars are returned to the front end of the furnace and at each end of the tunnel is a hydraulic elevator for handling the trucks. Rail skids for carrying the castings lead up to the front end of the furnace, and are so arranged that the furnace cars are loaded automatically by the action of the elevator. Similarly at the discharge end, skids are arranged to take off the castings as the cars, one at a time, are carried down to the tunnel level by the elevator. A line of cars, loaded with castings which are being annealed, is constantly passing through the furnace from front to rear and empty cars are constantly returning underneath through the tunnel. The time required for any given group of cars to pass through the furnace may be regulated by the rate at which fresh cars are admitted, since every time a cold car enters the front end, a hot car, with its load of annealed castings, is shoved out at the rear. The car platforms are provided with a thick layer of fire brick, which protects the running gear from the heat; the track is depressed so the platforms are level with the floor of the furnace, thus forming additional protection for the wheels and necessary iron work under the cars. The operation of the continuous furnaces has proved very satisfactory.

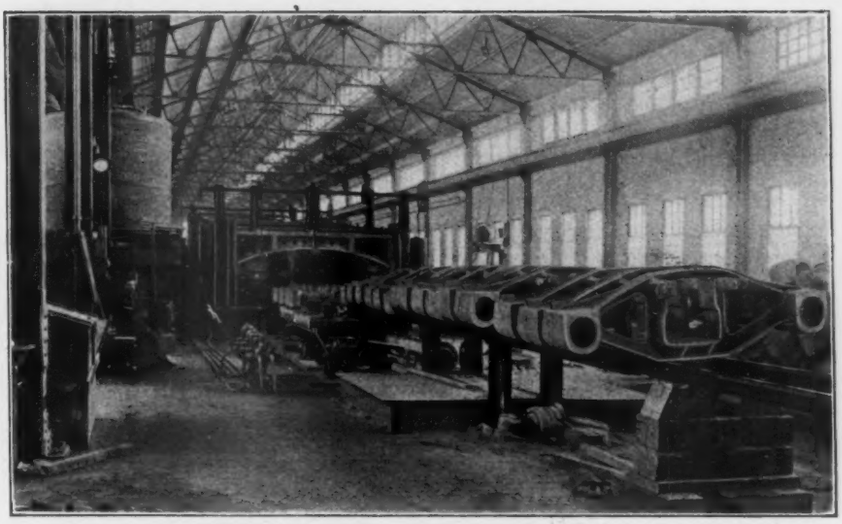


FIG. 6—ONE OF THE CONTINUOUS ANNEALING FURNACES

After being annealed, the castings are passed through a hydraulic straightening press of 775 tons capacity, which insures accurate alignment and also serves to test the strength of truck frames. The press is served by two jib cranes.

The west end of the chipping bays contains skids for holding castings during the final chipping operations and also for cleaning, painting and storing before shipment. Railroad tracks enter the building at the west end and the finished castings are loaded onto cars by traveling cranes. Five-ton cranes, 48-foot span, are provided for this work and for handling castings to and from the annealing furnaces and other apparatus.

Continuous Core Ovens.

Fig. 8 shows the continuous core ovens, which are installed in the west molding room. The core racks, instead of being carried on a car according to usual practice, are suspended from mono-rail trolleys, as shown in this illustration. The ovens are provided with doors at both ends and the trolley rails form loops; racks with fresh cores enter at the rear of the ovens and when the baking is completed, are hauled out through the front doors and allowed to cool. The ovens operate continuously. As far as possible, green sand cores are used in place of dried cores. Journal box cores are molded in green sand.

A metal pattern and machine shop, 200 x 50 feet, occupies the south wing of the plant. This shop is equipped with the necessary motor-driven tools for building and repairing metal patterns, molding machines and other ma-

FIG. 7—A VIEW OF THE PATTERN SHOP

chinery used throughout the foundry.

The wood pattern shop is on the second floor of a separate building, a short distance west of the main foundry. The shop is 50 x 140 feet, and is equipped with modern patternmaking tools, including motor-driven planers, jointers, pattern grinder, saws, band saw, lathes, revolving oil stone, etc.

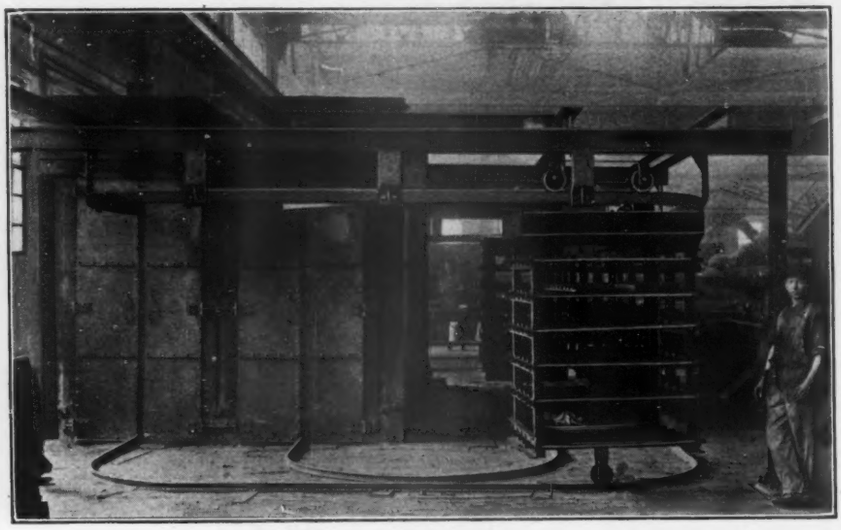


FIG. 8—ONE OF THE CONTINUOUS CORE OVENS

Swimming Pool for Employes.

On the ground floor of the same building is a large room fitted with individual, ventilated steel lockers for the use of the foundry employes. Complete toilet facilities, including a large swimming pool are also installed. The swimming pool is very popular and is used daily by the employes.

The foundry is provided with a well-equipped office building, which is situated a short distance north of the main structure. The laboratory occupies an annex at the southeast corner of the charging floor. The foundry employs about 500 men and turns out approximately 125 tons of good castings per day. Work on the buildings was commenced in 1909 and the first heats were taken from the furnaces in the summer of 1910.

Other Departments.

In addition to the steel foundry, the new plant of the Bettendorf Axle Co. contains a machine shop, 380 x 50 feet, power station, 220 x 50 feet, boiler house, 80 x 50 feet, and a car building or erecting shop, 2,100 feet long and 255 feet wide. The erecting shop is a steel frame structure with walls of red brick lined inside with vitrified white brick, resulting in a very light and pleasing interior. No built-up columns are used, heavy I- or H-sections being employed instead. The trusses and framing throughout are extra heavy. The building is divided into four longitudinal bays, the crane spans in each being 60 feet. The two north bays in the new addition are used for the fabrication and erection of underframes and steel cars. In the south center bay, the floors and sides are applied to the underframes, while the extreme south bay is devoted to the storage of small car parts and specialties. Running through this shop longitudinally are eight standard gage tracks connecting to the various yard tracks, which lead to the different parts of the plant and yard. Two locomotives and three locomotive cranes are used for switching. The plant has a total of eight miles of standard gage tracks.

To provide homes for the employes in the foundry and other departments of the plant, a town site has been laid out. The village, known as Bettendorf, now has a population of about 1,500 and is, to a large extent, under the control of the Bettendorf Axle Co. through a town improvement company. This company, under franchises obtained from the town council, supplies water and electric light to the village. About $100,000 has been expended in putting in the water and light plants, although there will be no direct financial return from this investment for several years. But it has given the growth of the town an impetus and aids in making comfortable, the homes of employes of the Bettendorf Axle Co. The town has also put in a sewage system and a modern school building has been erected.

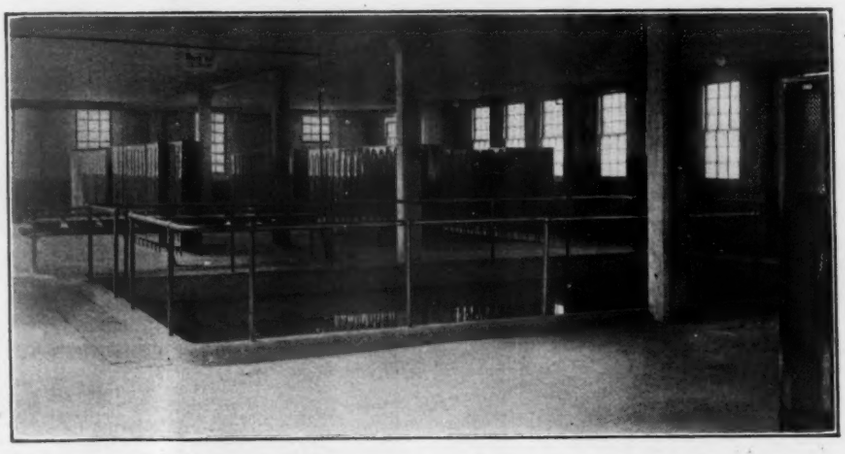


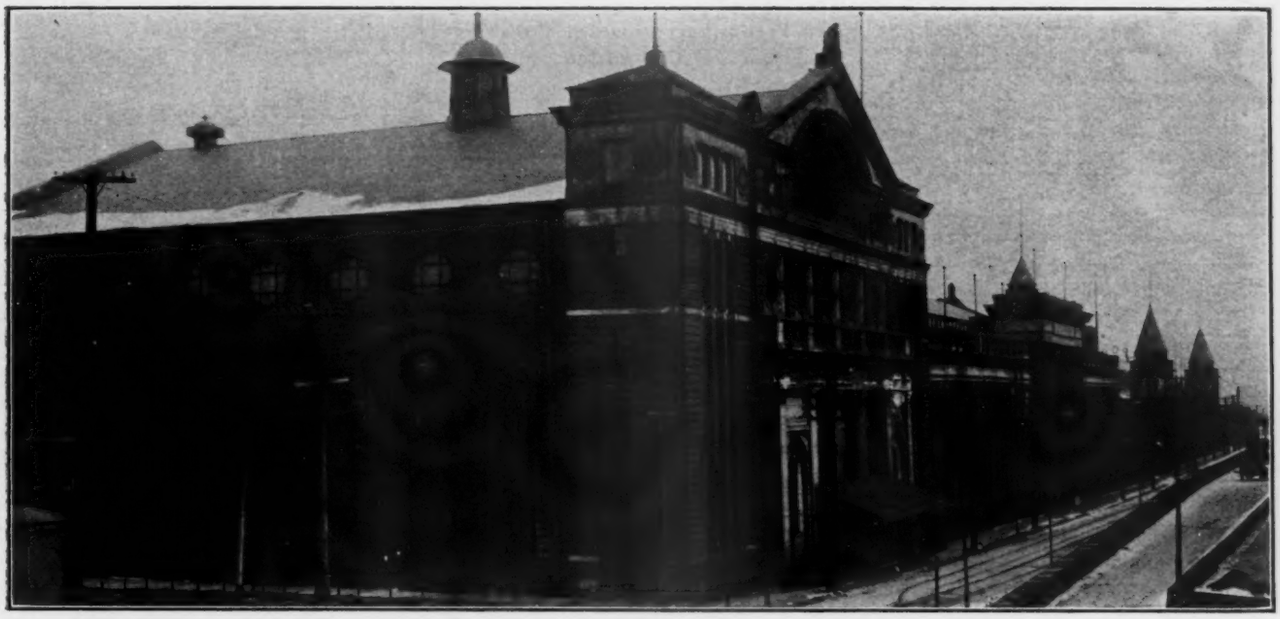
FIG. 9—LOCKER ROOM, SHOWING SWIMMING TANK IN THE FOREGROUND

Lower Fuel Ratio

By W. J. Keep

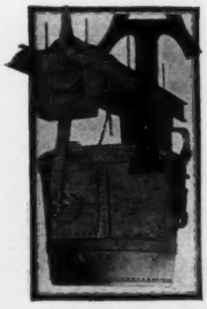
Question:—We operate a light casting shop and all of the work must come clean, as the castings are practically finished on all surfaces. Our melting ratio is 1 to 5, which we feel is entirely too high and we would like to reduce the coke consumption if possible. Our cupola is 42 inches inside the lining; the blast pressure is 8 ounces. The furnace has 12 tuyeres, the top row not being in use. Our heats average 6,000 pounds. We use approximately 600 pounds of coke on the bed. Our results have been very good thus far, but when we reduce the amount of coke throughout the heat the iron has been dull.

Answer:—You are doing very well and you will find that you cannot reduce your fuel ratio unless you increase your melt. The reason you have this low fuel ratio is due to the comparatively small amount of coke that you use for the bed. You probably charge 2,000 pounds of iron on the bed and follow this with two charges of 300 pounds of coke to 2,000 pounds of iron. By charging carefully and breaking your scrap into small pieces, you should be able to use 200 pounds of coke to 2,000 pounds of iron. If you make ten charges your fuel ratio will be reduced to 1 to 8.



Buildings of the Western Pennsylvania Exposition Society at Pittsburg, where the meetings of the Foundrymen's Associations and the exhibit of foundry equipment will be held

Program and Entertainment Features of the Foundrymen's Convention at Pittsburg



THE interest already manifested in the annual convention of the allied foundrymen's associations, which will be held in Pittsburg, May 23 to 27, foreshadows an unusually large attendance of foundrymen from all parts of the United States and Canada. As the greatest iron and steel-producing center in the world, the Smoky City has many attractions for those engaged in the manufacture of castings, and every opportunity will be afforded the visitors to inspect the many notable works that fringe the banks of the Monongahela and Allegheny rivers. Though Pittsburg is essentially a steel-producing center, its foundries, both in number and size, rank with the greatest casting producing centers in the country. The iron, steel and chilled roll industry of Pittsburg, whose growth has kept pace with the development of the steel trade, is an important factor in the foundry business of that territory. Roll foundry practice will prove a revelation to many of the visitors, as the casting of these large pieces requires great skill and methods that are peculiar to the practice and are not readily applicable in other branches of the founder's art.

With few exceptions, the foundries located in this valley are engaged in the manufacture of heavy castings, and the equipment, in nearly all of the plants, has been designed to facilitate the production of large work. Many of the shops make a specialty of rolling mill housings, large engine beds, and other castings required for rolling mill machinery. The molding methods conform to the latest and best practice, and molds, weighing many tons, are successfully made on molding machines. There are, also, many shops running on light work, operating continuously, whose daily output averages an enormous tonnage. The production is diversified, and the visitors will be permitted to inspect gray iron, steel, malleable and brass shops that rank with the most notable foundries in the world. W. A. Bole, of the Westinghouse Machine Co., has been appointed chairman of the plant visitation committee and he will be ably assisted by members of the Pittsburg Foundrymen's Association.

Convention Program.

H. E. Field, of Mackintosh, Hemphill & Co., is chairman of the committee in charge of the convention program. At the meetings of the American Foundrymen's Association a large number of excellent papers will be read treating on the various phases of gray iron, steel, malleable and pattern shop practice, and separate sessions will be held by the members of the American Brass Founders' Association which will not conflict with the deliberations of the American Foundrymen's Association.

To prepare suitable arrangements for the convention, Pittsburg foundrymen have appointed the following executive committee: Joseph T. Speer, chairman; F. H. Zimmers, secretary; J. S. Seaman, chairman of the finance committee; H. E. Field, chairman of the convention committee; W. A. Bole, chairman of the plant visitation committee; G. P. Bassett Jr., chairman of the ladies' entertainment commitee; E. D. Frohman, chairman of the ball game committee; W. B. Robinson, chairman of the press committee, and Eliot A. Kebler, chairman of the reception committee. The entertainment program that is being outlined will measure up to the well-known hospitality of Pittsburg foundrymen and the visiting ladies will be taken on sightseeing trips through the parks and to the institutions and points of interest for which the Smoky City is noted.

The Foundry & Machine Exhibition Co., successor to the Foundry & Manufacturers' Supply Association, has announced a change of dates for the Pitts-

burg exhibit of foundry supplies and equipment, to enable the members of the American Society of Mechanical Engineers, whose summer meeting will be held the week following the foundrymen's convention, to attend the exposition. The exhibit, therefore, will be formally opened on Tuesday, May 23, instead of the preceding day, and will be continued to Thursday, June 1, the closing day. The members of four great organizations will, therefore, be given an opportunity to attend this show, including those affiliated with the American Foundrymen's Association, American Brass Founders' Association, Associated Foundry Foremen, and the American Society of Mechanical Engineers.

The first concessions from the Western Pennsylvania Exposition Society, in whose buildings the exhibit and the meetings of the allied associations will be held, were for all available space in Mechanical hall and one-half of the main building. Four-fifths of this space was applied for by exhibitors before March 1, and it became necessary to obtain more space for the large number of manufacturers who had not definitely decided upon the extent of their reservations up to that time. Secretary C. E. Hoyt immediately began negotiations for additional space and secured all of the first floor of the main building, amounting to 42,900 square feet. This makes possible the largest exhibit of manufacturing equipment yet undertaken and foreshadows the most attractive show ever held in connection with the meetings of the allied foundrymen's organization.

The preliminary program, as announced, provides for a joint session of the American Foundrymen's Association, Associated Foundry Foremen and the American Brass Founders' Association, on Tuesday morning, May 23. Addresses of welcome and responses will be made and these will be followed by papers relating to foundry costs, insurance, contracts, etc. In the afternoon, meetings of both the American Foundrymen's Association and the American Brass Founders' Association will be held, at different hours, however, to enable the members of one organization to attend the meetings of the other. Two business sessions are also scheduled for Wednesday and one will be held Thursday morning. In the afternoon on Thursday, May 25, an excursion to foundries and steel works in the Pittsburg district has been outlined and in the evening an elaborate entertainment will be tendered the members of the various organizations by the Foundry & Machine Exhibition Co. The business sessions of the various foundrymen's associations will be held on Friday morning and in the afternoon the foundrymen will attend a ball game at Forbes Field. The convention will close with a subscription dinner on Friday evening, which is open to all who attend the convention or the exhibit. On Saturday, May 27, the exposition of foundry supplies and equipment will be open throughout the day and in the evening.

Preliminary Program, Pittsburg Convention

Monday, May 22, 2 P. M.

Registration only.

Tuesday, May 23, 9 A. M.

Registration.

10 A. M.

Joint session of the American Foundrymen's Association, Associated Foundry Foremen, American Brass Founders' Association and the Foundry and Machine Exhibition Co.

Addresses of welcome and responses.

Papers to be read and discussed:—
- Production Cost.
- Economic Foundry Insurance.
- Uniform Contracts.

2 P. M.

Meeting of the American Foundrymen's Association.

Papers on the following subjects to be read and discussed:—
- Unloading Methods.
- Use of Borings in Cupolas.
- Effect of Alloys in Cast Iron.
- Permanent Molds.

American Brass Founders' Association.

Papers to be read and discussed:—
- Vanadium in Non-Ferrous Alloys.
- Determination of Nickel in Bronzes.
- Pouring High Grade Bronzes.

7 P. M.

Formal opening of the exhibit of foundry supplies and equipment, under the auspices of the Foundry and Machine Exhibition Co., in the buildings of the Western Pennsylvania Exposition Society.

Wednesday, May 24, 9:30 A. M.

Papers will be read and discussed on the following subjects:—
- Rotary Blowers.
- Foundry Construction.
- Heating and Lighting Systems.
- Patternmaking.
- Molding Machines.

American Foundrymen's Association—Steel meeting.

Papers on the following subjects will be presented:—
- Acid and Basic Open-Hearth Processes.
- Electric and Converter Furnaces for Steel Castings.
- Effect of Vanadium and Titanium on Steel.

American Brass Founders' Association meeting.

Papers on the following subjects will be read:—
- Corrosion of Brass Foundry Products.
- Pyrometer and the Aluminum Foundry.
- Non-Ferrous Foundry Economies.
- Equilibrium Diagrams.

6:30 P. M.

Dinner of Pittsburg and Associated Foundry Foremen.

Thursday, May 25, 9:30 A. M.

Joint Session.

Papers on the following subjects will be read:—
- Measuring Temperatures.
- Molding Sand.
- Use of Alloys.
- Shot in Castings.

1 P. M.

Train excursion to foundries and steel works in the Pittsburg district.

8 P. M.

Entertainment by Foundry and Machine Exhibition Co. to members of all Associations and their guests in attendance at the conventions.

Friday, May 26, 9:30 A. M.

Separate meetings of all Associations for the election of officers.

3:30 P. M.

Pittsburg and Cincinnati ball game at Forbes field.

6:30 P. M.

Subscription dinner open to all who attend the convention or exhibition.

Saturday, May 27.

The exhibition of the Foundry and Machine Exhibition Co. will be open throughout the day and evening.

Refractory Cement

The H. W. Johns-Manville Co., New York City, is now manufacturing a refractory cement which, it is stated, will resist temperatures as high as 3,000 degrees Fahr. This cement can be used in furnace settings of various types, for lining cupolas and brass furnaces, assayers' crucibles, and oil burning, tilting and rotary furnaces. Fire clay is now largely used as a bonding material for lining furnaces and for the brick settings of furnaces of all types, and as this clay fuses the bond between the bricks is rapidly destroyed, developing cracks through which the gases of combustion enter, eventually weakening the brick and causing the walls to collapse. A coating for brick settings which has been given the trade name of "Brick-lime" cement, which prevents clinkers from adhering to the brick, sealing the pores, is also made by this concern. As the conditions under which these cements are used are variable they can be modified to meet special requirements.

Core Oven Temperatures

Question:—We would like to know the temperature for core ovens to obtain the best results.

Answer:—Several large concerns that have recently made tests to obtain the temperature of their core ovens to secure the best possible results, bake their cores during the day at a temperature of 500 degrees Fahr. This high temperature is essential to facilitate the drying of the cores, but when left in the oven at night, they are subjected to a temperature of only 350 degrees Fahr., as the drying period is considerably prolonged. Both small and large cores can be dried in the same oven by placing the small cores on the lower shelves, where they are not subject to as much heat as the large cores on the upper shelves. This arrangement will prevent the burning of the small cores on the lower shelves.

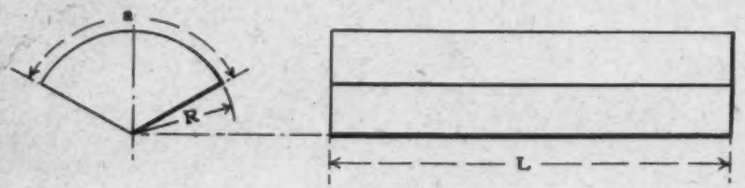
Payment will be made for all contributions on foundry and pattern shop practice suitable for publication.

FORMULAS FOR FINDING THE WEIGHTS OF IRON CASTINGS.

By W. L. Tryon.

To find the weight of a sector of a solid cylinder, multiply the radius squared, by the length, by the number of degrees in the angle, by 0.00227.

$$W = R^2La \times 0.00227.$$



To find the weight of a sector of a hollow cylinder, multiply the sum of the inside radius and one-half the thickness, by the thickness, by the length, by the number of degrees in the angle, by 0.00454.

$$W = (r + \frac{T}{2}) TLa \times 0.00454.$$

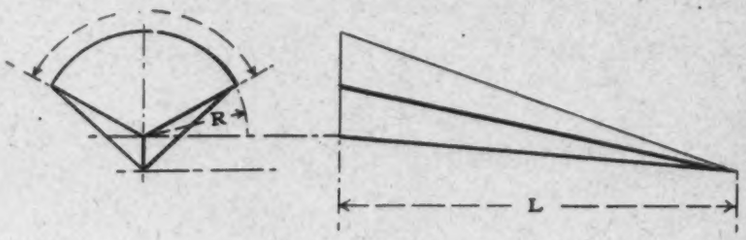
W = Weight of casting in pounds.
I. = Length of casting in inches.
R = Outside radius in inches.
r = Inside radius in inches.
T = Thickness in inches.
a = Number of degrees in the angle.

FORMULAS FOR FINDING THE WEIGHTS OF IRON CASTINGS.

By W. L. Tryon.

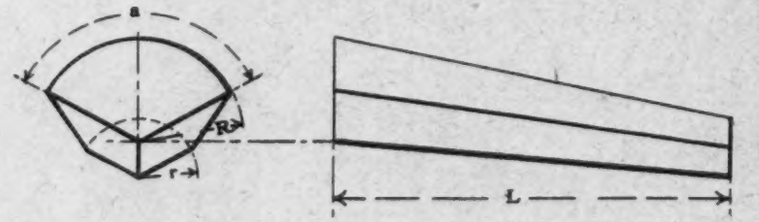
To find the weight of a sector of a cone, multiply the radius squared by the length, by the number of degrees in the angle, by 0.000757.

$$W = R^2La \times 0.000757.$$



To find the weight of a sector of a frustrum of a cone, multiply the sum of the radius of the large base squared, the radius of the small base squared, and the product of the radii, by the length, by the number of degrees in the angle, by 0.000757.

$$W = (R^2 + r^2 + Rr)\ La \times 0.000757.$$



W = Weight of casting in pounds.
L = Length of casting in inches.
R = Radius of large circular base in inches.
r = Radius of small circular base in inches.
a = Number of degrees in the angle.

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

THE BRASS FOUNDRY

Molding Manganese Bronze

By C. Vickers

MOLDS to receive manganese bronze should be rammed somewhat differently than those used for ordinary bronze or brass, as the latter metals will lay to a harder surface than the former, and even should a little bubbling, happen, no particular difficulty arises, as drossing does not readily occur from this cause. In the case of manganese or aluminum bronzes, however, bubbling or other uneasiness of the metal before it solidifies in the mold is a prolific source of dross, and this produces dirty and flaky spots, which render it necessary to take a heavy cut off the casting to remove these imperfections.

A practice often followed, therefore, when making patterns for manganese bronze castings that have a large surface to be machined, such as the rotor end plate, Fig. 2, is to make a much larger allowance for finish than is usual

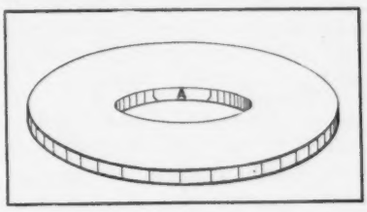


FIG. 2—MANGANESE BRONZE DISC

or necessary for ordinary alloys, so that defects due to dross, etc., can be machined off down to the sound metal. This increases the cost of the casting, not only on account of the extra machine work involved, but also because of the loss in the depreciation of the value of the chips that are turned off which, in the case of manganese bronze, or any copper alloy containing aluminum, is much greater than with ordinary copper alloys. This is due to the difficulty experienced in using them again, as their field of usefulness is greatly curtailed because of the aluminum present, which makes them impossible as an addition to ordinary brass or bronze, because of the excessive drossing effect produced. For this reason few foundries can use this scrap, and as the demand for these chips is limited they are of little value, so that the more material turned off, the greater the cost of the finished manganese bronze casting as compared with a similar casting in any copper-tin alloy. Consequently, it is quite a problem to use these chips so as not to experience a heavy loss, as they cannot be used by being proportioned with new metals on account of the great reduction in strength occasioned thereby. To produce the casting with the lowest possible loss, the mold must be constructed so that the metal will lie quietly, which means that the passage of gases through it must be guarded against. Although it may not be possible to prevent the formation of gases, they can be made to pass harmlessly out of the mold by the use of an open grade of sand and well-vented molds.

Care should be exercised to obtain the proper amount of moisture in the sand, which should be worked as dry as possible to reduce the generation of steam to the minimum. With the sand in this condition the vents and pores of the mold will be able to carry off the steam as rapidly as it is formed. Hard ramming will also close the pores of the sand and should be avoided. It is often an advantage, after facing the pattern in the drag with sand of an ordinary temper to back it with sand much drier than it is ordinarily used. By following this method of molding, the steam from the facing is driven into a strata of porous sand and in case the mold is skin dried, there is less chance of it sweating-back. Bubbling caused by hard ramming or wet sand, or both, while a fruitful source of trouble, is not the only cause of dross in manganese

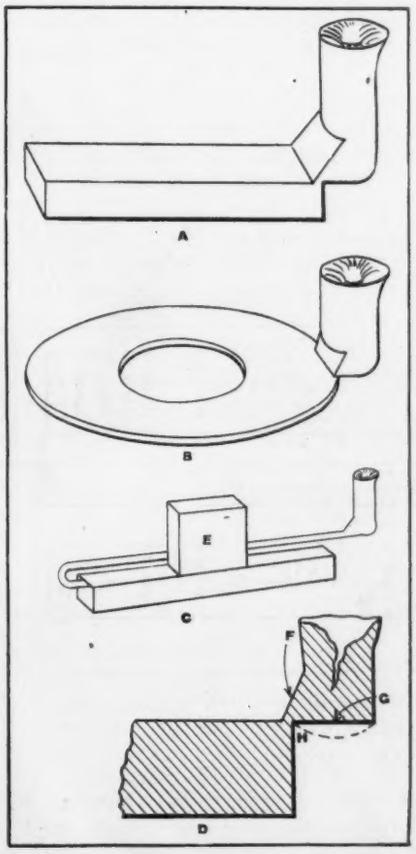


FIG. 1—METHODS OF GATING MANGANESE BRONZE CASTINGS

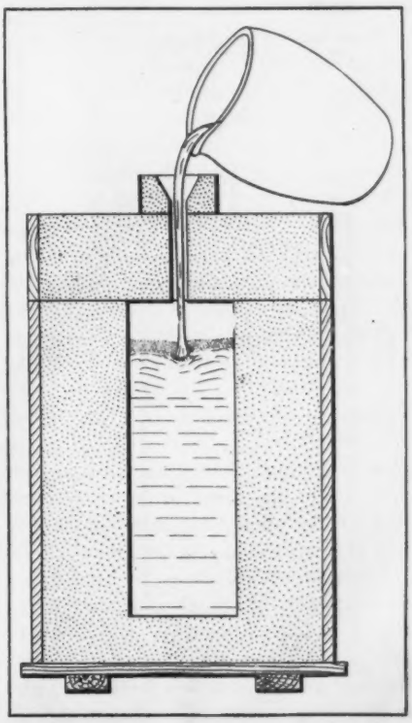


FIG. 3—POURING MANGANESE BRONZE

bronze castings, as any agitation of the metal will produce a similar result with copper alloys containing aluminum. This is due to what may be termed the saponifying effect the latter metal exerts on all copper alloys to which it may be added in sufficient quantity to be externally visible on the castings. In this respect these alloys, when in the fluid condition, greatly resemble soap suds and foam with the same ease. Therefore, if two streams of metal impinge when running into a mold, or if the metal drops into metal, or if boiling or bubbling arises from any cause, a foam is formed just as it would be with soapy water, and a study of the methods of running soap suds into different shaped vessels without creating foam will suggest many points of value in gating molds for manganese bronze, or any other alloy containing aluminum.

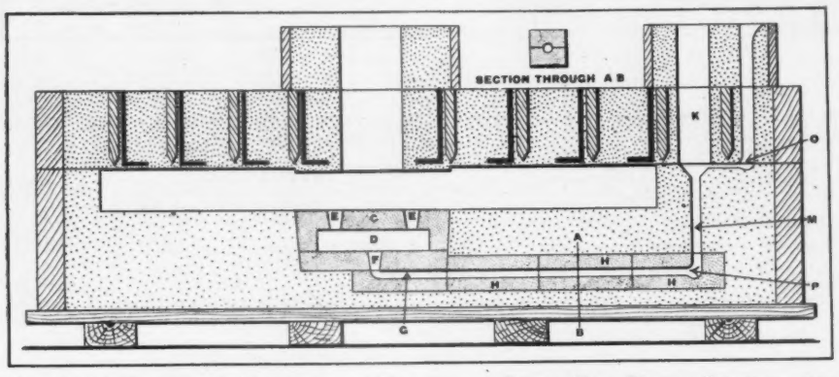


FIG. 4—LONGITUDINAL SECTION OF A MOLD FOR A ROTOR END PLATE, SHOWING THE METHOD OF GATING AND FEEDING MANGANESE BRONZE CASTINGS

Foaming of the Metal.

Suppose, for instance, soapy water is to be poured into a vessel with straight sides. If the stream is dropped in, the result is that the vessel cannot be filled with the water without considerable waste, as the foam will occupy the upper part of the vessel and will overflow as the liquid rises. If the soapy water is replaced by manganese or aluminum bronze, and the vessel by a suitable mold as shown in Fig. 3, the result of pouring by dropping in the metal will be similar to that of pouring the soap solution, but as the foam or dross formed by the agitation of the metal is prevented from overflowing by the cope, it will be crushed and flattened against this part of the mold by the static pressure of the sprue, and thus the top of the casting will be a mass of dross. If, instead of the soap solution being dropped into the vessel, the latter is inclined and the liquid is permitted to flow gently over the sloping side into the vessel less foam will be formed, and it will be possible, by careful manipulation of the stream to entirely fill it with the solution without making foam. The same method can also be adapted to the casting of manganese or aluminum bronze, and *A* and *B*, Fig. 1, show the application of this principle, which gives excellent results on flat or shallow castings where bottom-pouring cannot be applied. The gate is shown in greater detail at *D*, Fig. 1, which is a cross-section through both gate and casting, and it will be noted that the entrance for the metal is very small, the connection being made on one corner. This makes a heavy sprue necessary, and to derive the advantages of the sprue as a feeder through so small an aperture, it should be placed as near to the casting as possible. The side, *F*, is, therefore, considerably inclined and cut to lap over the edge of the cope half of the casting from 1-16 to ⅛ inch, forming the gate.

The bottom of the sprue is not dished, as shown by the dotted lines, as it is placed too near the casting to allow sufficient sand at *H*. If this were done, the narrow ridge of sand would be forced into the mold. As the gate is very narrow it has been found that the casting can only be fed properly when the sprue is on a level with the top of the casting. Being so thin the gate should be as wide as possible, and as a sprue of large diameter is necessary as a feeder, the gate should be as wide as the sprue. The gate should never be flared to the casting, but should have straight sides. The small opening of this gate is effective in holding back the dross formed by the stream of metal falling into the sprue and, in pouring, the latter should be kept full. The dross is thus kept from being drawn into the gate, where it would be trapped by the sloping walls and thus impede the metal flow.

Gating.

If the sprue is kept full and the flask is inclined toward the pouring end, the metal must ascend in the mold away from the sprue. The first metal that enters collects under the gate and soon this end of the casting is full. The stream of metal from the sprue has insufficient fall to produce a foaming action, but exerts a pressure that forces the metal gently up the incline and into a riser that may be placed at the other end. Less dross is formed by this gate than by the usual method, and it is well adapted for such castings as the small disc, *B*, Fig. 1. The square bar, *A*, Fig. 1, can also be gated, as shown at *C*. In this case the metal is carried to the bottom of the mold by a long runner which should be connected to the casting on a curve so the metal will not be stopped suddenly, but flows easily into the casting, the mold being inclined so that the metal will gradually ascend in the mold. A heavy feeder is placed over the center of the bar if it is to be tested, to insure dense and solid metal at this point, and the runner should preferably be small to permit the head of the sprue to be kept full while the mold is being poured.

Fig. 4 is a longitudinal section of the mold for the heavy, circular, manganese bronze disc shown in Fig. 2, and it will be noted that the gate is unusual in form and that it conducts the metal to the bottom of the mold where it first enters the dross chamber, *D*, before entering the mold. The entire gate is formed of cores and is shown assembled

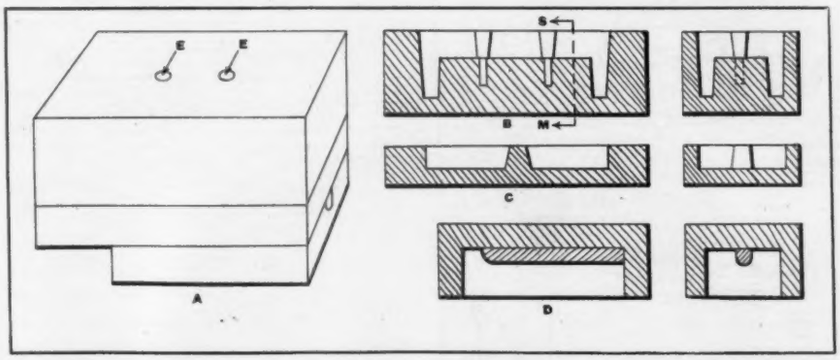


FIG. 5—LONGITUDINAL AND CROSS-SECTION OF A CORE BOX FOR A GATE CORE FOR CASTING MANGANESE BRONZE. THE CORE BOX ASSEMBLED IS SHOWN AT THE LEFT

at *A*, Fig. 5, while *B*, *C* and *D* are sections of the three core boxes. The chamber, *D*, Fig. 4, is rectangular and is formed by the core box, *B*, Fig. 5. The two openings, *EE*, for the entrance of the metal into the mold are formed by the loose plugs, in *B*, Fig. 5. The dross chamber is covered by the slab core, *C*, which has an opening *F*, in the center over which is pasted the core made in core box, *D*, forming the channel *G*. which, with cores, *H*, completes the runner through which the metal flows from the sprue.

Casting a Manganese Bronze Disc.

It will be noted that gates *EE* and *F* are tapered, being enlarged in the direction in which the metal flows. The object of this taper is to reduce the force of the metal as much as possible and to guard against any agitation of the metal which would cause dross. If the taper were reversed the bronze would rush out as from a nozzle, resulting in the formation of dross. This form of opening is only advantageous when the metal enters the mold from the bottom and would be of doubtful value when applied to a sprue, as it would permit the dross to be carried down, instead of allowing it to be dammed back and held at the top of a column of metal, as in the arrangement shown at *K*, Fig. 4. Here the large feeder is tapered to connect with the smaller feeder, *M*, and as the metal enters from the sprue, *O*, faster than it flows through *M*, it is held back by the contracted opening in the bottom of *K*, and, rising in the sand, forms a column of metal which carries off the dross, permitting the clean metal to flow into the mold. In spite of these precautions the metal is sufficiently agitated to produce some foam as it reaches the bottom of the sprue, *P*, and this is carried to the mold and more is formed when the velocity of the stream is checked by the end of the long gate. Therefore, some dross always enters chamber, *D*, where it is held. From *D* the metal quietly rises through the gates *EE* into the bottom of the feeder, and then flows quietly over the bottom of the mold.

While the bronze is being cast, it is advisable for the molder to watch the metal through the riser and if any dross is on the surface it is collected under the riser opening into the mold by means of a thin rod, bent at one end, so that it will be carried off through the riser. By this system of gating, clean manganese bronze castings are obtained, resulting in a great saving of metal and labor. In addition a light cut will only have to be taken off the castings instead of the heavy cut necessary when the ordinary horn gate method is followed.

The gate shown at *A*, Fig. 2, is as wide as the riser and is of the same depth as the casting. It is connected as shown in Fig. 4 and the heavy feeder is necessary to prevent shrinkage. The principle of this gate can be easily applied to manganese or aluminum bronze castings, other than the one illustrated, but if used for wheels or propellers which are gated on the hub, the dross chamber should be circular and the metal should be permitted to flow into the hub by three or more gates. Various modifications of this method of gating can be devised, and the shape of the chamber can be altered to suit any class of heavy work.

When considering the method of gating a manganese bronze casting it will be found helpful to keep the soapy water comparison in mind, and to devise means by which the metal can be poured into the mold without producing foam. When it is not possible to avoid a drop of the metal from one part of the mold to another on a lower level, the dross can be reduced to a minimum if the mold is inclined. Generally, however, all castings should be gated at the very lowest point of the mold, and shrinkage should be prevented by the use of risers. The dross in castings is formed in the gates and molds and is caused by foam produced by agitating the metal. The foam does not settle like soap suds, because the air imprisoned by the viscid molten metal forms oxides therewith, and the foam is permanent, being converted into dross. Manganese has a similar effect on bronze as aluminum, in that it causes a film of oxide to form on the surface of the metal, which is folded in and produces cold shuts, but it differs from aluminum in that it has no saponifying effect. Therefore, although bronze castings high in manganese are filled with defects due to these cold shuts, the drossing effect of aluminum is not evident, when the metal is dropped or two streams impinge. The casting troubles caused by aluminum in copper alloy are due to their excessive tendency to foam, the air being imprisoned and oxidation encouraged.

Modern Brassfounding in England

By A. Napier

ALTHOUGH it is the tendency for small manufacturing concerns to be absorbed by syndicates and large corporations, there are still quite a number of small brass foundries, also many iron foundries and engineering works, which run brass foundries as auxiliary departments. In the latter shops, the practice is often very haphazard, as the men who run them are better acquainted with iron founding.

It is a comparatively simple matter to melt stock bearing metal in a crucible, or to melt and pour babbitt for a machinery bearing, but in many cases, where a good bronze casting of definite strength, soundness and hardness is required, the means taken to produce these castings are very clumsy and unscientific. There is a great deal of skill required in melting and casting brass, as the melting points of the constituent metals differ so greatly that the resulting alloy may be far from what was anticipated, owing to the loss through oxidation and other causes.

Copper, the basis of all brasses and bronzes, possesses a melting point, when pure, of 1,950 degrees Fahr., and lead melts at 612 degrees Fahr. Since zinc, on being overheated, is lost as a vapor, it will readily be seen that great care is necessary to keep the loss within reasonable limits. Copper also, when in a molten condition, readily absorbs oxygen from the atmosphere, forming oxide of copper, which is objectionable in cast brass, and should be skimmed off. The pit furnace, fired with coke, is usually employed for brass melting in Great Britain, although the advantages of the modern coke tilting, and gas and oil furnaces are well appreciated. The general construction of the crucible pit furnace is well known, so that it will be unnecessary to refer to it further than to state that the greatest economy of fuel is obtained with not more than from 3 to 6 inches of fuel around the crucible, according to the quantity of metal to be melted; also, that the dimensions of the chimney should be approximately 17 to 20 per cent of the total grate bar area, the height varying according to local conditions, but it should not be less than 25 feet. The air should be allowed ready access to the fuel, through the grate bars, which should be placed not

more than 2 inches apart, to prevent the coke from falling through.

Gas-Fired Furnaces.

The gas-fired furnace is much advocated and has a number of points in its favor, the fuel consumption being less than with coke. Then there is the absence of clinker on the crucible and the consequent extension of its life. Gas is also more easy to regulate than coke, an important matter when handling alloys with low melting points. The first cost is higher, but many of these modern furnaces will repay this by their convenience. The reverberatory, or direct flame furnaces, burning oil fuel, possess some advantages, principally on account of the large amount of metal that may be melted. The ratio of air supply to oil requires careful regulation, so that proper combustion is obtained without an excess of air, which would give an oxidizing flame. The air supply should, in fact, be insufficient, for though that involves imperfect combustion, and smoke, it gives a reducing instead of an oxidizing flame.

Melting.

In the melting of brass, there is plenty of scope for the exercise of intelligence, as faults which are apparently very trifling, may have quite disastrous effects. In remelting scrap or ingot brass, a common mistake is made in packing the crucible too tightly with weighty pieces, and the expansion of the metal when heated often splits it. When the pot is charged with awkward and irregular pieces, these commonly have to protrude from the top until the lower portion is melted, in which case care must be exercised to prevent the metal from falling over the side into the fire, and to protect the copper and other constituents from oxidation, a covering of charcoal should be used. In a coke fire, sulphur may be absorbed from the coke if the metal is not protected.

Fluxes.

The use of charcoal is common with practically all of the non-ferrous alloys, as it effectively prevents contact with the atmosphere or furnace gases during melting. The charcoal should be crushed fairly small and be slightly damp, a small amount being placed in the bottom of the crucible before the metal is put in, and more added as it begins to melt. Sometimes coal or coke is used on account of the lower cost, but they are not to be recommended for good work, because they contain sulphur. Charcoal contains neither sulphur nor hydro-carbons, and readily produces the required protecting atmosphere. A number of other substances are also used, either as protecting mediums or to reduce the oxides formed during melting. Salt ranks as one of the most efficient of these, as it decomposes oxide of copper, thus preventing its absorption by the metal. A double handful of salt may be added before the crucible is placed in the fire, and more after the metal begins to melt. In some cases it is used after the crucible is removed from the fire, the metal then being well stirred, and the slag skimmed off before pouring. Plaster of paris is another popular flux with the brass founder, many claiming that it removes iron. Although this is not clear, it does dissolve oxides and removes silica, but it is open to the objection of giving off sulphur when in contact with coal or coke. Cyanide of potash is also a very good flux, and melts to a clear fluid, but in addition to being poisonous is very expensive, and attacks the crucibles strongly. Fluorspar is one of the best fluxes for general foundry work, as it dissolves the oxides and also any silicious material present. This fact makes it very suitable when melting washings, grindings, etc. It melts to a clear, limpid fluid, which attacks the crucible unless there is present a large amount of impurities to be slagged off. Accordingly, it is often used in conjunction with lime, which may be increased or decreased in amount to give a more or less fluid slag.

A useful mixture comprises 75 per cent fluorspar and 25 per cent of lime. Borax is another useful but expensive flux. In the absence of silicious material it acts well, dissolving the oxides, but, owing to its lack of effect on silica, it is not so generally applicable as some of the others. Sal-ammoniac has been tried at various times for brass melting, but it is not found to be efficient for copper or brass, though excellent for zinc. In addition to the non-metallic fluxes mentioned, a considerable number of deoxidizing substances are employed, many of them being specially prepared combinations of metallic substances. Among the best known are manganese, phosphorus, silicon and aluminum, which are used in varying proportions, according to the result desired. The use of larger quantities of manganese, phosphorus and aluminum, than may be necessary for the actual deoxidizing of the metal, is common for producing the well-known manganese, phosphor and aluminum bronzes and brasses.

Brass Making.

The usual practice in making brass is to first melt the copper, then to add the other metals in the solid state. A very effective way, and one that avoids the loss generally associated with brass in melting, is to melt the various constituents in separate crucibles and add them in a molten condition to the melted copper. Whichever way is adopted, however, when the metals are all alloyed, the mixture is thoroughly stirred and allowed to cool somewhat before being poured. It is necessary that the copper should be well covered with charcoal and be brought to a sufficient heat to melt the other metals, otherwise chilling will result, and the zinc will melt and lie on top of the copper without mixing properly. Then, when the whole becomes heated, volatilization of zinc will occur.

The proper temperature at which to add the zinc is indicated by a hissing noise. When it is introduced, thorough stirring is very important because of the lightness of the zinc, and it is well to leave the crucible in the fire a short time after the metal has been stirred, as this allows the oxide of zinc formed by the reaction of the spelter and the copper, to come to the surface. A dirty brass is liable to result from a too hasty removal of the metal from the crucible. The pouring temperature is an important point. If poured too hot, blow-holes will probably result, and if too cool, imperfect cohesion of the metal may occur.

Molds for Brass.

Although brass molding in general is very similar to iron molding, there are distinctions. In the first place, the sand should be of a finer grade, particularly when the castings are required with a fine finish and are not machined. When machined, a coarser sand may be used, which has the advantage of allowing the gas to escape readily. Venting is freely done in either case, but particularly with the fine sand. Generally, the gates and risers require to be larger than for iron, and this particularly applies to manganese bronze and similar alloys. For this class of work the rule of gating on the heavy part does not apply, better results being obtained from gating on the lighter part and putting risers on the heavy portions, the gates being designed to collect any dross that may enter, but they should not be so long as to unduly cool the metal and cause the castings to be misrun. Risers can be used with advantage more frequently than with iron, and should always be sufficiently large to keep fluid until after the casting is set, otherwise the tendency will be to draw from the casting and set up strains, producing a worse effect than if no risers were used. If arranged properly, the risers not only serve as feeding heads, but help to clear the castings of the drosses which form on the surface,

and which tend to accumulate in the upper part of the casting.

No facings are necessary for very light work if the sand is fine, as the facing would tend to close the pores of the mold, preventing the escape of the gases, thus stopping the flow of the metal. For medium weight castings, facings of flour, pulverized soapstone, or charcoal, may be employed. Plaster of paris and also bone dust are sometimes used, and a plumbago dressing is given molds for heavy castings. Most brass work is made in green sand, but dry sand is best for heavy work and manganese bronze. The cores should be fairly firm, though not as hard as for iron, and if freely vented, which is essential for brass work, they may be made of a fine, open-grained sand.

Large Bronze Doors

Large bronze doors made for the Unitarian Memorial Church, at Fairhaven, Mass, in the bronze foundry of Jno. Williams, Inc., 556 West Twenty-seventh street, New York City, are shown in the accompanying illustration. Each door is 14 feet high and 8 feet wide and each leaf, with the exception of the statuettes, was cast in one piece and weighs 4,500 pounds. The design of the door is based upon traditions of English Gothic of the last or perpendicular phase. The architectural and sculptural treatment of the faces of the doors is unusually elaborate. The central feature on the outside is a figure of Chirst in the act of benediction, set in a niche and sheltered by a canopy of intricate design bearing four angelic heralds. The central figure is flanked on either side by three of the Apostles, six in all, on the outer face, the other six being placed in corresponding positions on the inner face of the door. Forming a frame around the doors on both the exterior and interior, is a series of canopied niches filled on the exterior with figures representing great characters in the history of Christianity. The period from the beginning of the Christian era to the Reformation is represented by great men of the Catholic church, the Post-reformation by great reformers, members of the various Protestant bodies.

Aluminum castings used for miners' lamps have been found to sweat excessively with thin mineral oils, although perfectly tight to heavy oils, and the addition of zinc up to 10 per cent of the mixture failed to correct the trouble.

Sand for Brass Molding

By B. W. Preece

The average brass founder frequently declines profitable orders for tablets, or similar work that require a fine surface, under the mistaken impression that in making such castings high grade, special sands must be employed. In the largest foundries in the east, where high grade work of this kind is made, French sand, with few exceptions, is unknown, Philadelphia, Albany, etc., being the prevailing sands used. Some years ago the writer was employed in a large statuary foundry in the east where French sand was used and made castings with Philadelphia sand that were equal to the French sand castings, and the molds were made in a fraction of the time required by the latter method. The problem lies entirely in the careful preparation of the sand and I have yet to find a

Copyright, 1911, by Jno. Williams, Inc., Bronze Foundry, New York.

FIG. 1—CAST BRONZE DOORS FOR THE MEMORIAL CHURCH, FAIRHAVEN, MASS.

foundry in which a good grade of this work cannot be produced, providing an intelligent effort is made to use the available material.

Preparing the Sand.

To illustrate this we will suppose that a small foundry receives an order for a tablet and has fine Albany sand on hand. Sufficient sand for the job should first be thoroughly dried, and some advocate drying the sand in a crucible placed in a furnace. Much sand is ruined in this way and ramming an odd-side, which is placed against a stove to thoroughly dry the sand for the mill is to be preferred. If the shop is without a sand mill a small keg, or better still, a half barrel can be rigged up at very small expense to serve as a mill. Heavy weights are placed in the barrel with the sand, which is milled until it is of the consistency of flour. After the sand has been milled, the facing is made, and the importance of doing this properly should be emphasized. A good facing sand is one of the most essential features connected with the production of good castings. The best sand should be selected from the molding tubs and it should be dried sufficiently to permit it to be shaken through a very fine riddle. One part of this sand is added to two parts of the milled sand and to this, flour is added in the proportion of 1 to 20. The entire mixture is then shaken through a riddle. The sand is tempered with a solution of salt and water in the proportion of one pint of salt to a pail of water. After the sand has been tempered it should be placed on a board or in the molding tub and rolled until the sand becomes strong and tough. If the pattern will permit of double-facing, the mold should be rammed rather soft and when the cope is lifted off, the mold is sprayed lightly and fine sand is dusted onto it from a bag. The dust will absorb the moisture from the sand in two or three minutes, after which the surplus sand is blown off. The mold is then dusted with pulverized charcoal and is permitted to stand for a short time. The pattern should then be cleaned with a fine brush, as the moisture of the mold will cause the sand to adhere. By this time enough of the charcoal will be absorbed by the facing of the mold and after using the bellows freely, return the side. The back of the mold is scored deeply and then the mold is rammed again with a blunt iron. When the side is taken off it is dried against a stove, or if too large to be dried in this way a perforated pan on which a charcoal fire is built should be used. The pan should not be placed too close to the mold, as it is liable to injure the charcoal facing. Rubbing a finger nail on the joint will serve as a guide in drying. After the cope has been dried and cooled the face is cleaned, turned over, supported on horses and is smoked with rosin ignited in a small hand ladle. The purpose of this is to close

any pores in the sand that might be left after printing back. If the model does not permit a reprint, the facing should be made entirely of milled sand, the mold should be rammed harder than usual and should be smoked with rosin, as suggested.

Frequently these models are mounted on a plaster base which makes reverse-molding necessary. While this is a simple operation the number of molders familiar with it is comparatively limited. The required thickness of the casting being known, strips of wood of equal length are tacked to a smooth board, 10 inches wide and 15 inches long. These strips are attached to either side of the board and should be of the same thickness as the casting. Clay, worked to the consistency of putty, is used for bedding the model into an odd-side to the joint line. Care should be taken to make the joint firm and solid to avoid ramming it down. Clay is next rolled onto the board to which the strips are attached, and if the strips are of the proper thickness the clay, when rolled out, will be of the same thickness as the casting. By working the clay cake with the fingers it can be made to conform to any joint regardless of its irregularity. After the molding joint has been covered, the thickness strips are placed on the joints of the flask, which is then ready to be rammed. After ramming, the cope is lifted off and slightly dried to harden the surface. When cool, the drag can be rammed and after rolling over, the false cope is lifted off and shaken out. The only work required on the drag is to shave the diameter thickness. The cope is then molded, the clay is removed, the model cleaned thoroughly and the cope is ready, as previously described. When the cope half of the mold has been lifted off the model the drag side is dusted with charcoal and pinches of sand are placed at intervals on the clay thickness of the drag. The cope is then tried on, the molding being clamped, and after removing the cope the metal thickness will be indicated by the amount of compression of the small piles of sand.

Government Tests of Gun Metal

GUN METAL is a term usually applied to a very tough and strong alloy of copper, and before the advent of phosphor bronze represented the highest type of the alloy of copper and tin. Any alloy of copper containing from 6 to 12 per cent tin, either with or without the addition of zinc, is called gun metal, and this series of alloys has been extensively investigated by ordnance experts in order to determine which particular one is best adapted to the requirements of the service. These researches revealed many interesting facts in connection with these alloys which are of importance to manufacturers of high grade bronze castings, in that they indicated the most suitable alloy to select when castings of great strength are required. The physical properties possessed by some of these old guns, as shown by the tests, were of the highest quality.

Three old 12-pound guns cast in 1864 and tested at the Watertown arsenal gave results that are both interesting and instructive. The analyses failed to reveal phosphorus and in only one alloy was any trace of iron found. Two of the alloys were deoxidized with zinc and in one no deoxidizer was used. Its good casting qualities were no doubt due to the copper having been brought to a tough-pitch state in the furnace before the addition of tin was made. The guns were cut into sections in the lathe and longitudinal segments were taken out by the planer and from the latter tensile specimens were turned down from which the original properties of the metal were ascertained. The guns were numbered 1, 2 and 3, and the test specimens were taken from either end, at the breech and muzzle, and one point which will be noted with interest was the variation in composition and physical qualities between the two portions of the same casting. In addition to the tests which were taken of the original metal, samples from each of the guns, Nos. 1 and 2, were remelted and the metal was cast into ingots in iron molds from which further tests were taken. Finally, samples of the metal from guns Nos. 2 and 3 were remelted and additions of tin and zinc were made and tests taken from these ingots. Tests of the original metal taken from the guns showed that gun No. 1 had been cast from a mixture of copper, 88 per cent; tin, 10 per cent, and zinc, 2 per cent, popularly known as government gun metal or naval bronze. The mixture from which gun No. 2 was originally made was copper, 90 per cent and tin, 10 per cent, and the formula of gun No. 3 was copper, 90 per cent; tin, 8 per cent, and zinc, 2 per cent.

Table I.

CHEMICAL ANALYSES OF THE METAL IN THE THREE GUNS.

Gun No.		Copper, per cent.	Tin, per cent.	Zinc, per cent.	Iron, per cent.
1	breech	88.63	9.57	1.80	trace
1	muzzle	88.85	9.40	1.75	trace
2	breech	90.65	9.35	trace	
2	muzzle	90.50	9.50	trace	
3	breech	90.90	7.60	1.50	
3	muzzle	90.97	7.75	1.48	

In tensile strength the original metal from the guns ranged between the limits of 35,000 and 47,000 pounds per square inch, and when recast, between 32,000 and 43,000 pounds per square inch. After the addition of tin and zinc, 33,000 to 39,000 pounds tensile strength per square inch was obtained. Table I gives the chemical analyses of the metal taken from both breech and muzzle of each gun.

The physical properties of the metal in gun No. 1 were as follows:

	Breech end.	Muzzle end.
Tensile strength, pounds per Square inch	39,000	41,440
Elastic limit, pounds per square inch	14,000	14,000
Elongation, per cent	22.5	33.7
Reduction of area, per cent	19.5	29.1
Specific gravity	8.818	8.724
Hardness	4.51	4.22

Color of the Metal.

The color of the fracture at the breech was a uniform dull lavender yellow, and at the muzzle, a uniform golden yellow. The metal in the muzzle of the gun No. 1, as shown by the analyses, contained less tin and zinc than the breech, the alloy being accordingly somewhat softer. It would naturally be inferred, therefore, that there would be a decrease in tensile strength and an increase in elongation. The tests, however, showed that the muzzle not only possessed 11.2 per cent greater elongation than the harder metal at the breech, but also had a greater tensile strength. The specific gravity was less and the hardness test showed it to be softer, but it was evidently a much better metal in other respects. The decrease in the amount of zinc in the muzzle, being only 0.05 per cent, was undoubtedly too small to affect the result to the extent the tests showed, but an interesting fact developed by

the investigations of the ordnance experts is that zinc is worthless as an ingredient of bronze and very materially lowers its strength.

Gun No. 2.

This is borne out by the following tests of gun No. 2, made with an alloy without zinc:

	Breech.	Muzzle.
Tensile strength, pounds per square inch	43,800	47,000
Elastic limit, pounds per square inch	14,000	14,000
Elongation, per cent	31.2	40.7
Reduction of area, per cent	32.1	32.4
Specific gravity	8.595	8.731
Hardness	4.69	5.08

The color of the fracture at the breech was a uniform lavender yellow and at the muzzle a uniform dark yellow. The content of tin in the metal at the muzzle, as shown by the analyses, was only 0.07 per cent less than at the breech of gun No. 1, and a trace of zinc only was present, the 1.80 per cent of this metal in the breech of gun No. 1, and also the 0.07 difference of tin being replaced by copper in No. 2, which resulted in an increase in tensile strength in No. 2 of 8,000 pounds per square inch over the breech of No. 1, and 5,560 pounds per square inch increase over the muzzle of No. 1. Gun No. 2 developed greater elongation than No. 1, and was also harder metal. The specific gravity, however, was less than that of the metal at the breech of gun No. 1.

Gun No. 3.

The physical properties of gun No. 3 were as follows:

	Breech.	Muzzle.
Tensile strength, pounds per square inch	43,070	35,130
Elastic limit, pounds per square inch	13,000	12,000
Elongation, per cent	42.8	21.3
Reduction of area, per cent	33.5	29.1
Specific gravity	8.856	8.779
Hardness	4.42	3.33

The color of the fracture at the breech was a uniform reddish yellow and at the muzzle, a reddish yellow with spongy spots. The metal in the breech of this gun was much stronger and better than that at the muzzle, and it would be interesting to know to what extent this result was affected by the spongy spots found in the fracture of the muzzle. The elastic limit of this alloy was 1,000 pounds less than that of the 88-10-2 mixture, but in all other respects, and especially in elongation, it developed superior properties. A surprising feature is that the hardness test showed the metal at the breech of gun No. 3 was harder than the metal at the muzzle end of No. 1, although the latter alloy contained 1.65 per cent more tin and 0.25 per cent more zinc. The prevalence of the spongy spots in the mixture shows that it was not perfectly deoxidized, and when the evidence of the tests is considered it seems that this alloy, when properly deoxidized, could be used instead of the 88-10-2 mixture where the latter is usually employed and thus produce stronger castings at a reduced cost.

Tests of Recast Metal.

The recast metal specimens of guns Nos. 1 and 2 taken from the ingots cast in iron molds, possessed the following physical properties:

	No. 1 muzzle.	No. 2 muzzle.
Tensile strength, pounds per square inch	32,390	43,320
Elastic limit, pounds per square inch	10,430	16,800
Elongation, per cent	10.3	23.3
Reduction of area, per cent	14.8	21.6

The color of the fracture of No. 1 was a lavender yellow with a crystalline structure, and of No. 2, a light lavender crystalline structure. These results show that the 88-10-2 mixture deteriorated by being remelted. This is contrary to the general belief, as it has always been considered that a more homogeneous alloy is obtained by melting the metal twice. In the case of this alloy, this was not substantiated by the results of the tests. The 90-10 alloy also suffered considerably in tensile strength and elongation by being remelted, but the elastic limit was raised 2,800 pounds.

Remelted Metal From Gun No. 2.

The sample of metal from the muzzle of gun No. 2 that was remelted with the addition of 2 per cent tin possessed physical properties, as follows:

Tensile strength, pounds per square inch.	36,880
Elastic limit, pounds per square inch...	14,000
Elongation, per cent	5.7
Reduction of area, per cent	11.6

Color of fracture, yellowish gray.

The increase in the percentage of tin over 9.40 per cent, shown by the analysis, thus resulted in a considerable diminution in ultimate strength, while the elongation was dangerously lowered. Samples of equal weight were then taken from both the breech and muzzle of guns Nos. 2 and 3, and were melted together with the addition of ½ per cent of tin and 1 per cent of zinc. The results of the physical tests follow:

	Gun No. 2.	Gun No. 3.
Tensile strength, pounds per square inch	36,600	39,600
Elastic limit, pounds per square inch	12,000	9,200
Elongation, per cent	19.3	16.8
Reduction of area, per cent	24.4	15.2

Color of fracture of No. 2, golden yellow and lavender, and of No. 3, lavender.

The composition of heavy castings made from an alloy of copper, 90 per cent, and tin, 10 per cent, when cast in sand is never uniform. When large molten masses begin to solidify, an alloy poorer in tin than the mixture crystallizes first where the metal is chilled by contact with the mold. Its composition, according to Thurston, is about 92 parts by weight of copper and 8 parts of tin. The next portion solidifying is again richer in tin and this process is repeated as the metal continues to solidify inwardly until, as tests have shown, it is quite usual for a large casting of this mixture to be composed of 8 per cent tin on the outside and 12 per cent tin on the inside. To overcome this, a process of casting guns in iron chills was devised and applied in the United States by Dean, in 1869, and later by Uchatius, in Austria. As the date of the introduction of this process was five years later than when the guns discussed were cast, it is evident that they were not made in chills. Therefore, the tests can be taken as showing the strength that it is possible to attain with these alloys when cast in loam or dry sand molds. The casting of ordnance in chills was probably the first application of the permanent mold in the foundry and shows what progress had been made at that time in this branch of founding, when it was possible to make castings, some of which weighed thousands of pounds, in iron molds. In the case of the alloys, the use of some deoxidizer like phosphorus or manganese might have resulted in some improvement. The structure of the 88-10-2 mixture in particular is greatly improved by the addition of a small quantity of manganese, but whether the alloy is deoxidized or not the highest results are only attained when unremitting attention is given to the metal while in the furnace.

Sodium and Phosphorus in Bronze

To obtain some idea of the respective merits of sodium and phosphorus in bronze, a series of tests were carried out by making test bars of an alloy of copper 95 per cent, and tin 5 per cent. Some of the bars were deoxidized with phosphorus and others with sodium, and they were tested by being held in a vise and twisted, to determine the torsional strength. It was found that the sodium bars possessed a much greater torsional strength than the phosphorus bronze, as they withstood three complete twists before breaking off, while the phosphor bronze only stood one twist.

The sodium bronze, however, was a little harder than the phosphor bronze. When bent through 180 degrees the former alloy broke, while the phosphor bronze did not. Phosphorus also possesses the advantage of not distilling out of the metal by repeated melting and is more easy to alloy. Sodium or natrium bronze is an easy running alloy, the tensile strength of which is greater than that of phosphor bronze. Otherwise the two metals, when cast, greatly resemble each other. Sodium bronze when melted, emits a yellow flame, which is caused by the distillation of the sodium. Phosphorus and sodium should never be used together in the same alloy.

Brass Foundry Difficulties

SOLVED BY EXPERTS

Hot Bearings

Will you kindly give us a good formula for hot rolling mill bearings?

Try the following formulas: Copper 90 pounds; phosphor tin, 10 pounds. Copper, 85½ pounds; phosphor copper (15 per cent), 3½ pounds; tin, 8 pounds; zinc, 3 pounds.

Wax for Casting

When casting wax into plaster of paris molds, how are they prepared to prevent the wax from sticking to the mold?

The mold should be filled with cold water in order to moisten and cool the surface. The wax is then poured in and in 30 or 40 seconds a film of wax ⅛ inch in thickness will have formed. Then the surplus wax is poured out, leaving a wax casting of uniform thickness.

Tobin Bronze

We would like to have a good Tobin bronze mixture.

The alloy is similar to Muntz metal, Sterro metal, etc., and if aluminum is included in the mixture, it can be used as a manganese bronze. There are many variations of the original formula, and one that will run good, sound castings without the use of aluminum, is as follows: Copper, 57 per cent; zinc, 41.5 per cent; tin, 1 per cent, and manganese-copper, 0.5 per cent.

Imitation of Platinum

Can you inform us whether platinum has ever been successfully imitated by any alloy?

Numerous alloys have been developed to supplant platinum and although some of them have found fields of usefulness, we doubt if they are equal to platinum. This metal is an element with properties peculiar to itself. A patent was issued some time ago to C. H. Birmingham for an alloy called "Pro-platinum," which the inventor claims is equal to platinum. The analysis of this alloy follows: Nickel, 72 per cent; silver, 23.57 per cent; bismuth, 3.72 per cent, and gold, 0.71 per cent.

Metal Patterns

We would like to have a mixture for white metal patterns as we are having some difficulty with the mixture we are using. We would also like to have a mixture for wax patterns.

The following mixtures are suitable alloys for white metal paterns:

	Tin, Per cent.	Lead, Per cent.	Copper, Per cent.	Antimony, Per cent.	Zinc, Per cent.
1	37	0	3	10	0
2	40	46	0	12	0
3	15	75	0	10	0
4	0	87	0	13	0
5	10	80	0	10	0
6	8	0	8	0	84

To alloy No. 6, add ½ ounce of aluminum.

A formula for wax patterns follows: Bees wax, 1 pound, and venice turpentine, 1 ounce.

Copper Anodes

We would like to obtain some information regarding the casting of brass and copper anodes, as the castings we make are a dark drab color, while we would like to have them bright and clean.

The difficulty mentioned is caused by the sand burning onto the castings and can be remedied in the case of copper by using 100 pounds of copper which is melted under charcoal, to which is added 1 pound of silicon-copper. Incline the mold while pouring and let the metal enter at the lower end so that it will run uphill, and take a riser off the high end and dust the molds with soapstone or talc, instead of either flour or plumbago. If the usual formula for brass anodes is used, namely, copper 66 pounds and zinc, 34 pounds, the castings will most probably show up with a disagreeable color, no matter what is put on the mold, and the usual way is to clean them with an acid. They can, however, be greatly improved by the addition of silicon-copper in the proportion of from 1 to 2 per cent. This will give them a bright yellow, clean appearance, and will be better for this purpose than aluminum.

Dirt in Bronze Castings

We have lately experienced considerable trouble with bronze machinery castings which contain dirt in the cope. The castings are bench-molded in iron flasks and weigh several pounds each. A considerable part of the casting is exposed in the cope and has only a small finishing allowance. When machined, the dirt, while superficial, extends deep enough to cause the castings to be rejected. We are satisfied that the dirt is not sand as it is black and appears to be graphite.

Copper, when in molten condition, will absorb a small amount of graphite, but it must be very hot to do this and we doubt if enough would be absorbed to produce the effects you describe. However, if thus absorbed, the graphite would probably be retained and would be distributed throughout the metal, only being visible in the fracture as black spots. It is our opinion that the trouble is caused while pouring-off and we suggest that you watch this process and observe particularly whether the lip of the pot rests on the edge of the flask when pouring the metal. This will cause this difficulty, especially when large crucibles are used and the molds are low, but it is more liable to happen when the pouring is done with side tongs than when a shank is used. The reason this trouble is intermittent is due to the fact that it does not happen so frequently in the case of old pots as with new crucibles. The dirt comes from the pot and is graphite, as you suggest. It is

caused by the pot slipping when it is tilted on the edge of the flask, thus scraping off graphite from under the lip each time the crucible is tipped. This dirt falls down the slope at the mouth of the sprue and is washed into the mold by the stream of metal. The remedy is to raise the pot so that it does not touch the flask when pouring. This may work a hardship on the men when pouring, but the molders will attend to this when they understand the reason for holding the crucible in this way.

Cheap Anti-Friction Alloy

We would like to obtain a formula for an anti-friction alloy that will be both cheap and good. Can you give us such a formula?

An ordinary grade of anti-friction metal can be made from lead, antimony and tin in the following proportions: Lead, 80 pounds; antimony, 15 pounds, and tin, 5 pounds. First melt 60 pounds of lead, bring to a red heat and add the antimony gradually until dissolved; then add the balance of the lead and last, the tin. These additions will bring the temperature of the metal to a point suitable for pouring into ingots. The anti-friction qualities of this alloy can be further improved by the addition of bismuth, the formula then being as follows: Lead, 79 pounds; antimony, 15 pounds; tin, 5 pounds, and bismuth, 1 pound. Another anti-friction alloy that is somewhat harder is made as follows: Lead, 78 pounds; heat red and add 17 pounds of antimony, and when dissolved add 4 pounds of tin and 1 pound of 5 per cent phosphor-tin.

Special Red Brass

Will you oblige us with a formula for a red brass, suitable for casting sprinkler heads and other small castings?

An alloy that will be found very satisfactory for this purpose is as follows: Copper, 88 per cent; zinc, 6 per cent; tin, 3.5 per cent, and lead, 2.5 per cent.

Glue as a Core Binder

We would like to obtain a formula for making cores with glue as a binder, as we understand that it makes excellent small cores and requires no venting.

Use 1 pound of glue in 100 pounds of sand for small cores. This, however, can be varied to suit the requirements of each individual case, according to whether hard or soft cores are desired. If the sand is moist it is not advisable to add much water to the glue to avoid getting the sand too wet. If the sand is dry the glue can be diluted with sufficient water to bring the sand to the proper temper for use. The best way to melt the glue is to cover it with cold water and let stand until thoroughly softened, when it will easily liquefy on being heated in a double boiler. The sand mixture will have to be governed by the class of cores it is desired to make and may consist of 30 parts of gangway sand, 30 parts of new molding sand and 40 parts of sharp sand mixed with the glue as previously suggested. It will be found advisable, in all cases, to vent the cores, as the glue generates gas when the cores are burnt by the metal, and large cores made in halves should be sprayed with molasses water before being put into the oven. You will probably obtain better results in making cores without vents by substituting glucose for the glue. It should be used in the same proportions as the glue, but generates less gas and, therefore, is not so liable to cause blowing.

White Alloy for Small Castings

We would like to obtain the formula of the white alloy that looks like silver largely used for making typewriter parts and other small castings. It has always been our opinion that this alloy was merely 18 per cent German silver, but we found that German silver is not strong enough for these castings.

You will find that the addition of from 1 to 3 per cent of aluminum to 18 per cent German silver will produce an alloy similar to the one you describe and scrap German silver will probably prove just as satisfactory. If the alloy is made from new metals either of the following formulas can be used:

(1) Copper, 60 per cent; nickel, 20 per cent; zinc, 18 per cent; aluminum, 2 per cent.

(2) Copper, 62 per cent; nickel, 20 per cent; zinc, 15 per cent; aluminum, 3 per cent.

Use a new crucible when first making the alloy. Place powdered charcoal in the bottom of the pot and charge the copper and nickel together. Cover the metal with charcoal mixed with borax and when melted, add the aluminum; stir thoroughly to dissolve the nickel and then add the zinc. The metal should not be allowed to become so hot that the zinc is strongly volatilized. Generally, when the nickel is melted and the zinc added, the metal will be found sufficiently hot to pour thin castings. Therefore, further heating should be avoided.

Electrical Resistance Alloys

An alloy of high electrical resistance which is ductile and not liable to corrosion when exposed to the air, was recently patented by Wilbur B. Driver, East Orange, N. J. The inventor claims to have discovered that nickel, when added to an alloy of copper and manganese, has the property of "fixing" the electrical behavior of the alloy so that it becomes reliable and constant.

The specific resistance of each alloy in the following formulas is given in michroms per cubic centimeter, the resistance of ordinary copper being 1 2/3 michroms, which is taken as the unit:

Copper, per cent.	Manganese, per cent.	Nickel, per cent.	Specific Resistance, per cent.
60	10	30	65
45	10	45	68
75	15	10	53
65	15	20	61
70	20	10	68
60	20	20	75
50	20	30	88
40	20	40	98
65	25	10	85
60	25	15	93
55	25	20	95
55	30	15	113
50	30	20	123
50	35	15	124
40	40	20	150

The inventor states that the electrical resistance of 18 per cent German silver is about 18, and that of 30 per cent German silver, 28. He adds that his experiments indicate that there must be 10 per cent or over of nickel conjointly with 10 per cent or over of manganese in alloy with copper, and that these proportions make an alloy that is a ductile and stable electrical conductor having an abnormally high specific resistance.

Valve Difficulties

We are making valves of the following composition: Copper, 86 per cent; tin, 7 per cent; zinc, 4 per cent, and lead, 2 per cent. Some of our castings have brown spots about 1 inch above the parting line, more often on the cope side, at which point the castings leak. Can you offer any suggestion that will help us?

In making valves a certain percentage of loss seems to be unavoidable, but it can be kept down by the use of charcoal and salt when melting the copper, and also by the use of a small quantity of phosphor-copper as a deoxidizer. Not more than one-half of 1 per cent of the 15 per cent phosphor-copper should be used in the steam metal formula given. We would suggest that the tin be reduced one-half of 1 per cent and phosphor-copper substituted. The cost of the alloy would not be increased and a denser metal would be obtained.

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Trade Outlook

An encouraging feature of the iron trade situation is the decline in pig iron stocks at western Pennsylvania and Ohio blast furnaces. In February there was only a slight reduction, but during the month of March these piles of iron were cut into at the rate of nearly 2,000 tons daily. In previous months the increase was variously estimated at from 75,000 to 100,000 tons and the increased melt of iron since February, therefore, totals nearly 150,000 tons per month. While this is largely steelmaking iron, merchant furnaces report that the tonnage in their yards is steadily declining and they are in receipt of urgent shipping instructions from foundrymen, who, in some instances, are anticipating deliveries on their contracts. This is an indication of increased activity in the gray iron, steel and malleable branches of the foundry industry, yet the abstinence of railroad buying has materially curtailed the available tonnage. It is reported that in February, the total tonnage received from the railroads by the largest steel producing interest only represented 8 per cent of the total tonnage booked for that month, and this can be taken as a fair estimate of railroad buying generally. It is conceded that price fluctuations in pig iron through the remainder of the year will be unimportant, and this is reflected by the quotations named by some of the blast furnace operators for deliveries extending through the third quarter. In the leading centers, No. 2 foundry iron is quoted as follows: Pittsburg, $14.15; Chicago, northern, $15; Cleveland, $14.25; Philadelphia, $15.50; New York, $15.50. The following prices are quoted on other grades of foundry iron: Lake Superior charcoal, $17.50, Chicago; malleable Bessemer, $15, Chicago; basic, $14.65, Pittsburg, and $15.25, Philadelphia. In the brass foundry trade the volume of new business that is being placed is large, although a lessened demand for castings is reported by foundries specializing in automobile work. The price of tin continues to fluctuate violently as the result of aggressive manipulation by the European syndicate. Sales have been made, in carload lots, at 41 cents, although slightly lower prices have been made during the month. Electrolytic copper is selling at 12.50 cents, New York, for 30-day delivery, and lake copper is held practically on the same basis. The lead market is quiet and the prevailing quotations range from 4.40 to 4.50 cents, New York. Spelter is held at 5.60 cents, and Cookson's antimony at 9.50 cents, New York.

The International Molding Machine Co.

Edward A. Pridmore, W. W. Miller and D. C. Snow, of Chicago, who have been doing business temporarily under the firm name of the Edward A. Pridmore Co., have adopted the permanent name of the International Molding Machine Co. J. W. Dopp, who was connected for about six years with the Tabor Mfg. Co., Philadelphia, as western sales manager, has been appointed general sales manager of the International Molding Machine Co. He will also act in the capacity of special representative in the central west, where he is well known in the foundry trade. In addition to being a salesman of wide experience, Mr. Dopp is a practical foundryman and a molding machine expert, having had charge, for a number of years, of the molding machine departments of several of the largest shops in the country, including the Cambridge, Mass., plant of the International Steam Pump Co. and the Lowell Machine Shop, Lowell, Mass.

Tensile Strength of Charcoal Iron

To the Editor:

Referring to the article entitled "An Unusual Tensile Test," published in the March issue of THE FOUNDRY, we wish to advise you that for some time we have been using charcoal iron which, in the form of a round test bar, cast 1¾ inches in diameter and turned to 1⅛ inches, has a tensile strength of 44,030 pounds per square inch.

PHILADELPHIA ROLL & MACHINE CO.,
Philadelphia.

Personal

C. P. Karr, metallurgist of the Nathan Mfg. Co., New York City, has resigned.

Nelson F. Flanigan has been appointed foreman of the Weiner-Barnet Co.'s brass foundry, Newark, N. J.

J. R. and J. M. Battenfeld, of the Berkshire Mfg. Co., Cleveland, sailed for Europe on the Adriatic, Saturday, March 18. While abroad they will visit Germany, Russia, England and France, to promote the sale of the extensive line of molding machines manufactured by the Berkshire company.

Ellsworth M. Taylor has resigned from the firm of Touche, Niven & Co., and has established an office at 30 Broad street, New York City, where he will engage under his own name as an expert in business and factory organization, etc. The resignation of Mr. Taylor dates back to Dec. 31, 1910, and he has taken over all of his personal business as of that date.

FOUNDRY and PATTERN SHOP EQUIPMENT

Motor-driven floor grinder --- The Mott sand blast --- Soft metal melting furnace --- Rotary sand sifter

IN THE accompanying illustrations is shown a motor-driven grinder, built by the Bridgeport Safety Emery Wheel Co., Bridgeport, Conn., which is adapted not only for grinding, but for buffing, polishing, etc. Wheels can be attached to the spindle at either end and in Fig. 1 a buffing wheel has been attached to the right end of the spindle, while on the opposite side a grinding wheel is attached. In Fig. 2, the machine is shown equipped for grinding, a water pot being attached to the side of the frame. The grinder is also manufactured with an attachment for grinding twist drills. To operate the grinder, the door in the frame is opened to permit the operator to reach the starter, which throws on the current gradually. For stopping the motor, a snap switch is provided at the side of the frame. This machine is manufactured for direct or alternating current. As originally designed, the machine was intended as a bench grinder, but as the demand for this device as a floor grinder has been exceedingly heavy, its manufacture has been specialized along this line. The general dimensions of the machine follow: Height from floor to center of spindle, 40 inches; diameter of spindle in bearings, ¾ inch; diameter of spindle between flanges, ⅝ inch; distance between wheels, 17 inches; length of spindle, 22 inches, and weight, with base, 350 pounds.

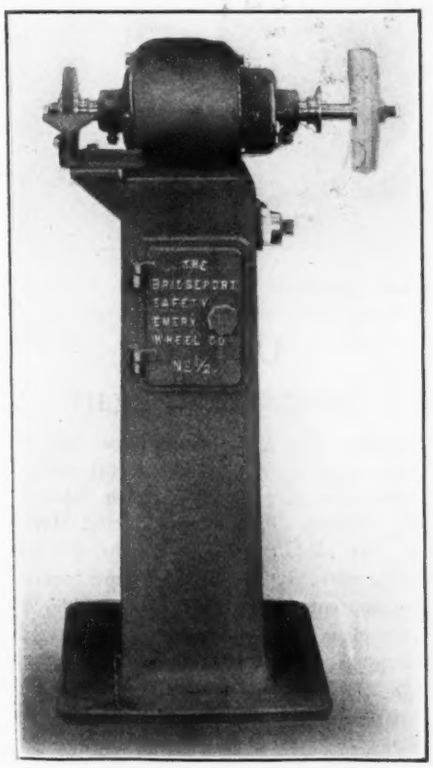


FIG. 1—MOTOR-DRIVEN FLOOR GRINDER, EQUIPPED WITH WHEELS FOR GRINDING AND BUFFING

Large Bronze Castings

An exceptionally large bronze drum was recently cast at the plant of the Buffalo Foundry & Machine Co., Buffalo. The drum was 12 feet long, 5 feet in diameter, and is used as the drying surface in a large vacuum rotary drum dryer. These drums are generally made of air furnace iron, but in this case it was found necessary to use a bronze casting, owing to the fact that the vegetable extract to be dried on the drum would become discolored if it came in contact with iron.

The mold for this casting was swept in dry sand, the core being swept in loam. When the casting was poured the mold was in a vertical position and the surface of the casting was absolutely free from blow-holes. As it required 16,000 pounds of metal to pour the casting, the mixture was melted in a 48-inch cupola.

The Wentworth Institute

A new industrial school known as the Wentworth Institute will be established in Boston, on a site of 12 acres recently acquired. The corporation was formed in 1904, and the trustees have waited until this year to begin building in order to leave the principal of the endowment unimpaired. The buildings to be erected include a power plant, 80 feet square, and the foundry will be located in the wing to this structure. Laboratories will also be erected for work in the departments of practical mechanics, electrical engineering, machine tool construction and mechanical drawing. Tool and machine design, etc., will also be taught. Arthur Lyman Williston, late of the Pratt Institute, Brooklyn, has been appointed the executive head of the Wentworth Institute.

In making provision in his will for the establishment of this school, Arioch Wentworth stated that the purpose of the institute should be to furnish "education in the mechanic arts". The aim of the institute, therefore, will be to teach trades, but its courses will be founded on the scientific principles underlying the various processes and methods employed in them. To utilize the plant to its maximum capacity there will be both day and evening classes, as there is a great demand for evening instruction on the part of those who are already employed in the various trades. The short courses of the school will be designed for apprentices and the longer and more thorough courses for those who hope to become superior workmen, master mechanics and foremen.

"Titanium in Steel" is the title of a 44-page booklet, recently issued by the Titanium Alloy Mfg. Co., Oliver building, Pittsburg. It contains much valuable information regarding the use of titanium as an alloy, and many well known experts are quoted relative to the use of titanium as a deoxidizer, etc. A large number of tests are also included, which show the favorable results obtained from the use of titanium in steel.

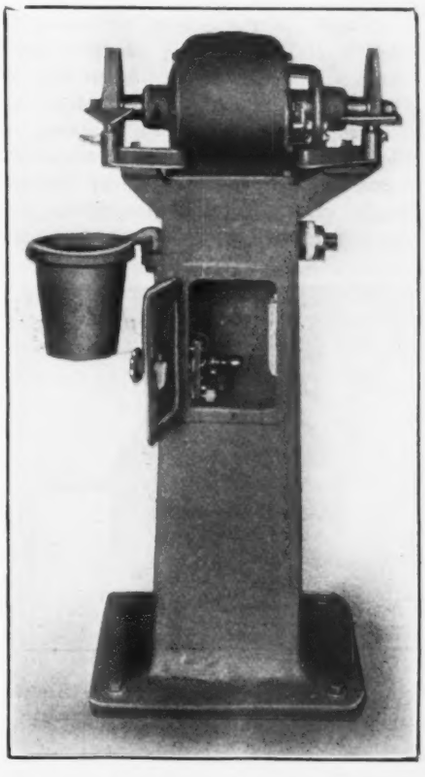


FIG. 2—MOTOR-DRIVEN FLOOR GRINDER, ARRANGED FOR WET GRINDING

The Mott Sand Blast

In the accompanying illustrations is shown an exceedingly simple sand blast, manufactured by the Mott Sand Blast Mfg. Co., 24 South Clinton street, Chicago. The apparatus is shown in Fig. 1, the tanks being made in two sizes, 14 inches in diameter by 36 inches long long. The smaller device is equipped with a ⅛-inch sand nozzle, and the larger sand blast with a ⅜-inch nozzle. This device consists of an air-tight

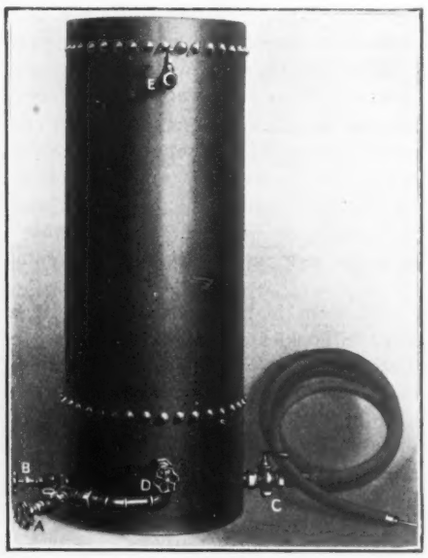


FIG. 1—THE MOTT SAND BLAST

sand tank, to the bottom of which is fitted a cast iron mixer provided with pipe connections, as shown in Fig. 2. The angle valve, *A*, is connected to the air supply and when the machine is filled with sand and all the valves are closed, the operator first opens the air supply valve, *A*, and then opens the direct pressure valve, *B*, which blows

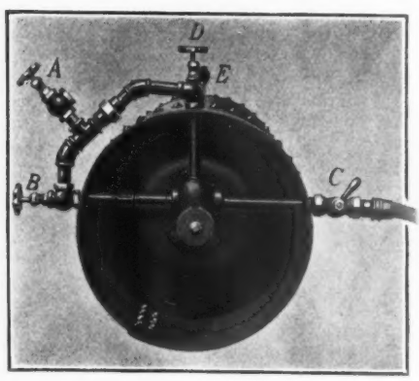


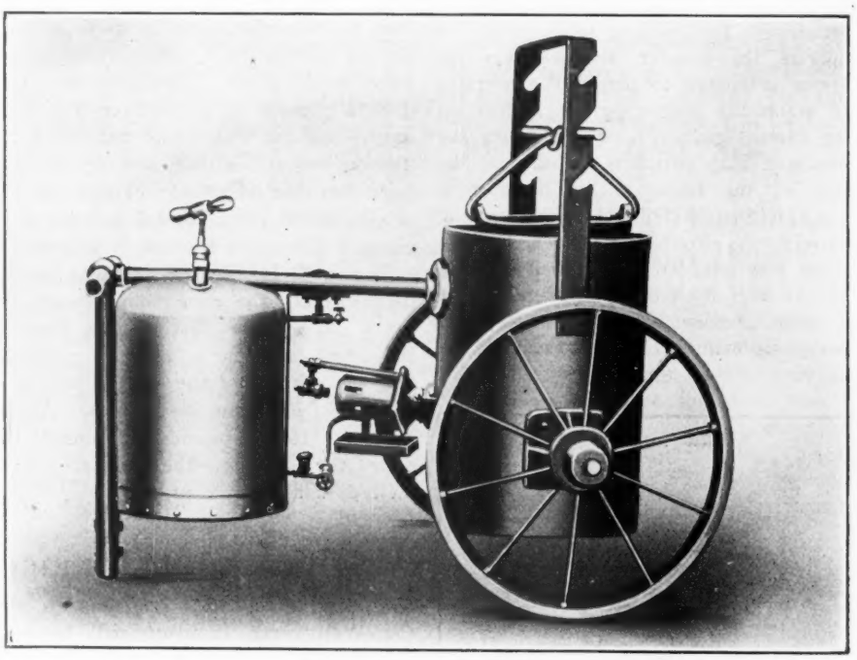
FIG. 2—BOTTOM OF SAND TANK, SHOWING CAST IRON MIXER

the compressed air through the blast pipe, *C*. The sand pressure valve, *D*, is then opened slowly, releasing the sand which falls from the tank directly into the path of the air passing through the mixer from the valve, *D*. The amount of sand delivered to the nozzle depends upon the relative opening of valves, *B* and *D*, the maximum amount being obtained when *D* is wide open and *B* practically closed. The machine having been adjusted, it is only necessary to shut-off the stop cock, *C*, when stopping for a short period. When stopping for any considerable time, however, the valve, *A*, should also be closed, and in starting up again, it is merely necessary to open *A* and then *C*. To fill the machine with sand, the valve, *A*, is closed, shutting-off the pressure, and release valve, *E*, is opened. Air pressure may be blown back into the tank to clear the mixing valve of a chunk of sand or gravel by closing valves, *C* and *D*. Under ordinary circumstances, however, when once the proper mixture of sand and air is secured, the valves, *B* and *D*, should not be disturbed.

For foundry use, the tank is mounted under a hopper that is enclosed by a hood, under which the sand-blasting is done. The used sand is collected in a hopper, from which it may be drawn out and placed back in the tank, as required. Any type of air compressor may be used in connection with this apparatus, the machine being designed for pressures between 30 and 125 pounds per square inch. In foundries not provided with a supply of compressed air, the machine may be connected with the cupola blower, as it is claimed that it will operate successfully on a blower pressure of from 5 pounds per square inch, upwards.

Soft Metal Melting Furnace

In the accompanying illustration is shown a soft metal melting furnace, combined with a kerosene torch, manufactured by the Hauck Mfg. Co., Brooklyn, N. Y. The furnace is portable, being mounted on two wheels, and is adapted for melting babbitt, lead and other soft metals. The outfit is entirely self-contained and, being portable, can be used in any part of the foundry or machine shop. The furnace shell is of steel plate construction, to the front of which the oil burner is attached. The oil storage tank is attached to the handle of the outfit. The furnaces are made for operation either with or without compressed air.



SOFT METAL MELTING FURNACE

Death of James McTaggart

James McTaggart, supervisor, for the past eight years, of the metal cabinet division of the National Cash Register Co., Dayton, O., died in that city, March 3. Mr. McTaggart was born Feb. 1, 1857, near Dumbarton, Scotland, served his apprenticeship as a brass molder at that place and later worked in several shops in and around Glasgow. At the age of 22, he removed to the United States and secured employment at his trade in New York City, where he worked in a number of foundries. In 1882, he entered the employment of the Yale & Towne Mfg. Co., Stamford, Conn., and seven years later was appointed foreman of the brass foundry,

a position he retained until 1895, when he accepted a similar position with the National Cash Register Co.

Mr. McTaggart was appointed supervisor of the metal cabinet department in 1903. In this capacity he had charge of all of the operations necessary for the manufacture of cash register cabinets, from the raw material to the finished cabinet. He was responsible for many improvements in the production of fine castings for cash register parts, which affected both quality and output, and had just recently completed extensive changes in the National Cash Register Co.'s foundry, as a result of which the output was materially increased. Mr. McTaggart was engaged in the brass foundry business for more than 40 years.

Rotary Sand Sifter

In the accompanying illustrations is shown a rotary sand sifter, which consists of two wire mesh cylinders, each 30 inches long. The inside cylinder is 14 inches in diameter and the outside cylinder, 24 inches in diameter. The cylinders are mounted on a heavy revolving frame. By means of a series of rollers and lugs, the riddle is jolted four times during each revolution, thus breaking the lumps and preventing the sand from clogging the mesh, and consequently it passes through the sieve as fast as it can be shoveled into the cylinder. The sieve is tilted to carry off stones, iron and other foreign matter, which is dropped through a chute at the end of the machine, Fig. 2. The extreme height of the sifter is 3 feet 9 inches and the width 2 feet 5 inches. The frame is well built of steel angles and the machine can be easily moved from floor to floor by two men. In Fig. 2, it will be noted, that one man is shoveling the sand into the cylinder while the other operator is turning the crank shown in Fig. 1. The sifter is furnished with pulleys for electric, compressed air or belt drive and a compressed air motor of the reciprocating type is recommended for power operation. This rotary sand sifter is built by the Arcade Mfg. Co., Freeport, Ill.

FIG. 1—ROTARY SAND SIFTER

Owing to its rapidly increasing business, the Detroit Foundry Supply Co., Detroit, has increased its capital from $25,000 to $40,000.

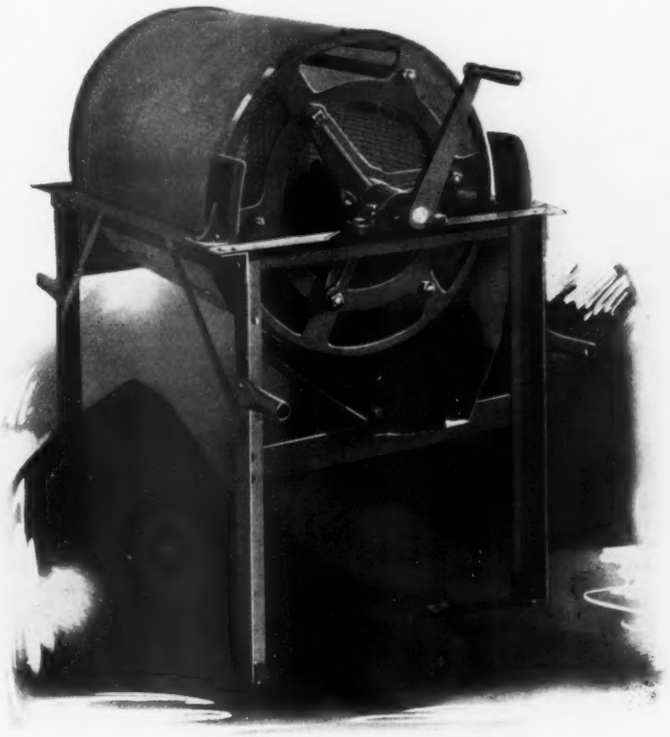


FIG. 2—ROTARY SAND SIFTER EQUIPPED FOR HAND OPERATION; THIS SHOWS THE DISCHARGE END

Trade Notes

Wallace Buell has resigned as general manager of Abendroth Bros., Port Chester, N. Y., manufacturers of soil pipe, heaters, furnaces, etc.

The S. Obermayer Co., Cincinnati, has established a New England branch in charge of Wm. Fitzpatrick Jr., at 44 Stonehurst street, Dorchester, Boston, Mass.

The Smooth-On Mfg. Co., Jersey City, N. J., is sending a 16-page circular to the foundry trade, containing extracts from its recently published "Instruction Book."

The Oliver Machinery Co., Grand Rapids, Mich., manufacturer of woodworking machinery, has opened a branch office in suite 400-423 Bank of Commerce building, St. Louis. A. S. Kurkjian is manager.

The Independent Pneumatic Tool Co., Chicago, has issued a four-page bulletin, describing its line of air tools and pneumatic appliances, including riveting and chipping hammers, air rammers, woodboring machines, etc.

The Mumford Molding Machine Co., 30 Church street, New York City, announces the appointment of Carl Falk as its Buffalo sales representative. Mr. Falk was formerly connected with the Herman Pneumatic Machine Co., Pittsburg.

The Detroit Steel Products Co., Detroit, has been appointed exclusive distributors in the United States for the metal casement windows, manufactured by the Crittall Mfg. Co., Ltd., London, England. These metal casement win-

dows are used in high-class buildings of all kinds.

The Pawling & Harnischfeger Co., Milwaukee, manufacturer of cranes, at a recent meeting of the board of directors elected S. H. Squier a director and secretary of the company; W. H. Hassenplug was elected a director and second vice president, and F. P. Breck, a director.

Martin Burns, superintendent of the foundry operated by the Lunkenheimer Co., Cincinnati, has resigned and has organized the Cincinnati Bronze & Aluminum Casting Co., 2129 Barnard street, Cincinnati. This concern will engage in the manufacture of brass, bronze and aluminum castings.

The Detroit Core Machine Co., Detroit, is sending to the trade a folder which briefly illustrates and describes its foot power core machine. Either wood or metal core boxes can be used to advantage, and when the core boxes are small, two or more can be attached to the machine at the same time.

The Ingersoll-Rand Co., 11 Broadway, New York City, in a 20-page bulletin, recently issued, illustrates and describes its extensive line of straight line, steamdriven, single stage air compressors. A table of various sizes and capacities of compressors is included for steam pressures from 80 to 120 pounds.

S. Twist, formerly associated with the Gurney Foundry Co., Toronto, Ont., has resigned to accept the position of mechanical superintendent of the foundry of the Dominion Stove & Foundry Co., Penetang, Ont., Can. This concern is erecting a new plant for the manufacture of stoves, ranges and furnaces.

In a four-page bulletin, issued by the Cleveland Blow Pipe & Mfg. Co., Cleveland, dust collecting systems of various kinds are illustrated and described, consisting of exhaust hoods for installation on tumbling mills, emery grinders, buffing and polishing wheels and other dust producing machinery. In addition, this concern manufactures exhaust fans, ventilation machinery, safety guards, etc.

The Hanna Engineering Co., Chicago, has entered into a contract with the Electric Machinery Sales Co., Milwaukee, to succeed this concern as general sales agent for the Ajax line of electric riveting machines, which are made in various sizes, including semi-portable riveters with 36-inch yoke for riveting sheet steel, tanks, etc., and with 12-inch yoke for riveting double edges and reinforcements on tanks, ovens, etc. Another stationary yoke type is used for riveting pipe and cylinders, while bench and pedestal types are made in three sizes for both electric and belt drives.

General Industrial Notes

The Aluminum Pump Valve Co. Cleveland, has been incorporated with a capital of $20,000 to manufacture valves. James E. Householder is manager.

The Steel Products Co., Columbus, O., recently incorporated, has leased the foundry of the Taylor Steel Co., at Plain City, O., and has placed it in operation.

The Keystone Steel Casting Co., Pittsburg, has been incorporated with a capital of $700,000. The incorporators are J. Sauers, J. P. Conn, J. Werkersacher, T. Beihl and C. Beihl.

The Evansville Marine Motor & Foundry Co., Evansville, Ind., has been incorporated with a capital stock of $20,000. The incorporators are B. F. Drury, C. F. Donnely, and B. M. Mitchell.

The Security Foundry Co., Minneapolis, manufacturer of furnaces, water heaters, and other heating devices, is building a new plant which will consist of a foundry 55 x 65 feet; machine shop 55 x 75 feet, and a fireproof pattern storage.

The Booth Copper Co., Toronto, has consolidated with Wm. Coulter & Sons of the same city, and the business will be carried on under the name of the Booth-Coulter Copper & Brass Co., Ltd. This concern is engaged in the manufacture of brass castings.

The Hesse-Martin Iron Works, Portland, Ore., has been incorporated and has acquired the plant and business of the Heacock & Lawrence Iron Works of that city. The new concern will make a specialty of railroad crossings, frogs, switches, and architectural castings.

The Quadruple Steam Pump Co., Jersey City, N. J., has been incorporated with a capital of $25,000, and will engage in business as tool-makers, brass founders, metal workers and boilermakers. The incorporators are A. McNeil, J. W. Darbyshire of Jersey City, and F. E. Collier, New York City.

The Mummack Foundry Co., Detroit, has purchased the plant of the Wolverine Foundry Co. and will carry on a general foundry business, manufacturing gray iron castings, stove and furnace repairs, plumbers' supplies, hardware specialties, etc. J. M. Weidinger is president, A. R. Mummack, vice president and manager, and W. Kerlewatz, secretary.

The Seitz Automobile & Transmission Co., Detroit, is equipping a large plant at Monroe, Mich., for the manufacture of crucible steel castings. The shop will be known as the Seitz Crucible Steel Foundry. The plant consists of two buildings, each 50 x 140 feet, with wings on either side, 26 x 140 feet. The foundry will be equipped to produce both crucible and converter steel castings and will be of sufficient capacity to not only provide castings for the Seitz Automobile & Transmission Co., but for the trade as well. A crucible steel furnace has been installed, also a converter and cupola. The foundry will be under the management of Malcolm MacLeod, who has had a wide experience in the production of crucible and converter steel castings.

New Construction.

The Simpson Windmill & Machine Co., Fairbury, Neb., is erecting a foundry, 40 x 50 feet.

The Jones Machine Co., Chattanooga, Tenn., is enlarging its plant by the addition of a foundry.

The Buckeye Iron & Brass Co., Dayton, O., will erect a one-story, reinforced foundry building on East Third street.

The Ideal Foundry Co., Chatham, Ont., is erecting a foundry for the manufacture of gray iron, brass and aluminum castings.

The Wise Furnace Co., Akron, O., manufacturer of furnaces, has acquired a site for a new factory and will erect a foundry and machine shop.

The Union Iron Works, Decatur, Ill., will erect a plant to consist of a foundry, 60 x 125 feet; machine shop, 50 x 135 feet, and a woodworking shop, 70 x 70 feet.

The Sanford-Day Iron Works, Knoxville, Tenn., manufacturer of stoves, are building a new foundry, which is expected to be ready for occupancy about May 1.

The Aransas Foundry, Machine & Boiler Works, Aransas Pass, Texas, will build a plant to consist of a foundry and machine shop, 40 x 60 feet and a blacksmith shop and office building.

The Bertsch Foundry Co., Cambridge City, Ind., will build a new plant consisting of a foundry, 30 x 150 feet; machine shop, 60 x 150 feet; pattern storage, pattern shop and warehouse.

The South Houston Iron Works, South Houston, Texas, will erect a foundry and machine shop at Tuscaloosa, Ala. The foundry will be 40 x 50 feet, and the machine shop, 30 x 50 feet.

The Kelly Foundry Co., Elkhart, Ind., will erect a foundry, 60 x 200 feet, machine shop, 60 x 100 feet as well as a pattern shop. This concern will engage in the jobbing gray iron foundry business.

The Gulf Iron Works, Tampa, Fla., manufacturer of phosphate mining machinery, is erecting a building, 50 x 100 feet, two stories high, which will be used as a machine shop and iron and brass foundry.

The Railway Brake Shoe Co., Moundsville, W. Va., will erect a plant which will include the following buildings: Foundry, 80 x 100 feet; two-story annealing shop, 80 x 100 feet and a two-story machine shop, 50 x 120 feet.

The Central Foundry Co., Oklahoma City, Okla., manufacturer of iron, brass and aluminum castings, is building a new plant which includes a foundry, 50 x 150 feet, fireproof pattern storage, 35 x 50 feet, and other buildings.

The McFarland Foundry & Machine Co., Trenton, N. J., iron and brass founder, has enlarged its plant by an extension to the main foundry and the erection of a two-story structure, the first floor of which will be used for cleaning castings and the second as a brass foundry.

The Tacoma Foundry & Machine Co., Tacoma, Wash., is building a new plant on a 3-acre site conveniently located to the center of the city. The complete foundry equipment, including the patterns owned by the late Gawley Foundry & Machine Works, has been purchased, which places the new company in position to handle all castings required by the lumbering interests of the district. J. Taylor is president, W. Webb vice president, and T. B. Hall secretary and treasurer.

CRANES

ALL TYPES FOR ALL PURPOSES

15-Ton 3 Motor Electric Traveling Crane, Foundry of Ferguson & Lange, Chicago, Ill.

Complete Equipment for Foundries

FOR ALL CLASSES OF CASTINGS

Grey Iron, Brass, Car Wheel, Pipe, Steel and Malleable

Layouts Furnished - Equipment Installed

Plants turned over to owners Ready to Operate

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PITTSBURG, Samuel W. Hay's Sons, 1415 Keenan Bldg.
CINCINNATI, S. Obermayer Co.
ST. PAUL, Robinson, Cary & Sands Co., 4th & Wacouta Sts.
RICHMOND, VA., Smith - Courtney Co.
BIRMINGHAM, ALA., Dewstoe Machine Tool Co., Brown-Marx Bldg.
DENVER, Hampson-Fielding Engr. Co., 1711 Tremont St.
WASHINGTON, D. C., H. A. Gillis, Home Life Bldg.
SALT LAKE CITY, F. E. Arnold, Atlas Block.

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PORTLAND, ORE., Chas. F. Beebe Co., 46 Front St.
SAN FRANCISCO, Henshaw-Bulkley & Co., 19 Fremont St.
MONTREAL, Dominion Foundry Supply Co., 47 Murray St.
WINNIPEG, J. A. McTaggart & Co.
EDMONTON, ALTA., Gorman, Clancey & Grindley Co.
MEXICO CITY, Mexican Steel Products & Machinery Co.
MONTEREY, MEX., Sanford & Cia.
LONDON, ENG., J. W. Jackman & Co., Ltd., Caxton House, West
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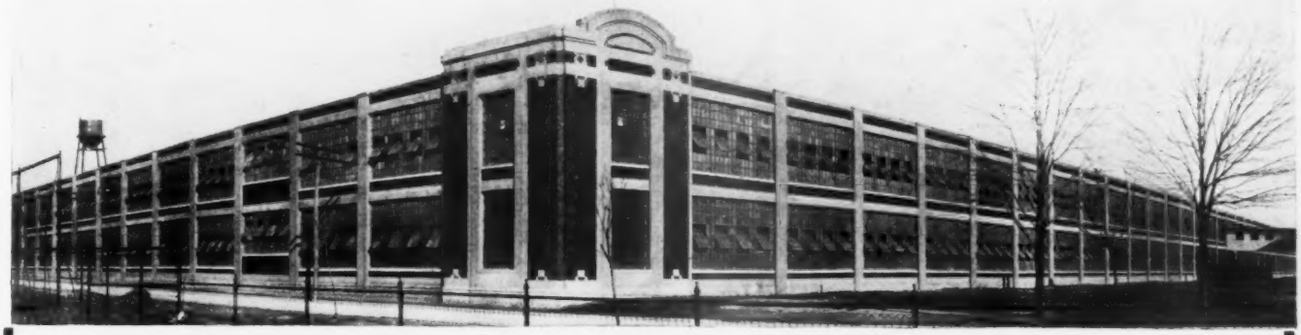
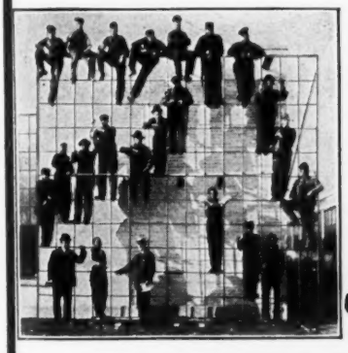
This picture shows how the walls of your factories may be made all windows---flooding the interior with invigorating daylight and fresh air---quickening labor efficiency.



The New "Fenestra" Fitted Plant of The Hudson Motor Car Company, Detroit, Mich.

"Detroit-Fenestra" Windows mean 25% more daylight and fresh air as required for factories than is possible with any other form of construction. They command a small premium in price over wooden windows, but do not require constant outlay for renewals and repairs. They are dividend payers, cost-reducers, and fire-retarders. They lessen your maintenance charges and artificial light bills, and when considered from a practical business standpoint, are never discarded in favor of wooden sash. ¶ Note the small illustration of the "Fenestra" Joint. This is the key-note of the strength of "Fenestra" construction. The *solid* rolled steel bars from which "Fenestra" is made are joined and permanently locked by this means with practically no loss of metal at point of intersection to weaken and allow vibration.



The "Fenestra" Joint

Practically No Metal Lost

Detroit-Fenestra
PATENTED

"Daylight for Factories"

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Grand Rapids Pumping Station, Grand Rapids, Mich.
City of Buffalo Pumping Station, Buffalo, N. Y.
U. S. Steel Corporation, Gary, Ind., and Bellaire, O. Duluth, Minn., and Birmingham, Ala.
Nelson Valve Co., Philadelphia, Pa.
American Optical Co., Southbridge, Mass.
Michigan Alkali Co., Wyandotte, Mich.
Lehigh Valley Coal Co., Scranton, Pa.
Woolson Spice Co., Toledo, O.
M. J. Whittal, Worcester, Mass.
Peninsular Stove Co., Detroit, Mich.
Packard Motor Car Co., Detroit, Mich.
Lozier Motor Co., Detroit, Mich.
Hudson Motor Car Co., Detroit, Mich.
Ford Motor Co., Detroit, Mich.
Leonard Storage Building, Detroit, Mich.
Detroit Edison Co., Detroit, Mich.
Solvay Process Co., Detroit, Mich., and Syracuse, N. Y.
Anderson Forge & Machine Co., Detroit, Mich.
Detroit Twist Drill Co., Detroit, Mich.
Pennsylvania Railroad, Frankford
Roundhouse, Frankford, Pa., Orangeville Roundhouse, Orangeville, Md.
New York Central & Hudson River R. R., West Albany, N. Y.
Chicago & Northwestern Ry., Power Station and Shops at Chicago, Ill.
U. S. Navy Dept., Mare Island Navy Yard, San Francisco, Cal.
Proctor & Gamble Co., Ivorydale, Ohio.
American Radiator Co., Buffalo, N. Y., and Kansas City, Mo.
Detroit Stove Works, Detroit, Mich.
Great Lake Engineering Works, Ashtabula, Ohio
Deere & Company, Moline, Ill.
The Aeolian Company, Garwood, N. J.

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We carry standards and near standards in stock for **immediate** shipment.

Detroit Steel Products Company, Manufacturers, Dept. 414 Detroit, U. S. A.

WHERE TO BUY

AIR COMPRESSORS.

American Air Compressor Works, New York.
American Compressor & Pump Co., Baltimore.
Curtis & Co. Mfg. Co., St. Louis, Mo.
Gardner Governor & Fdy. Co., Quincy, Ill.
General Electric Co., Schenectady, N. Y.
Ingersoll-Rand Co., New York, N. Y.
Norwalk Iron Works Co., So. Norwalk, Conn.
Pangborn Company, Thomas W., New York.
Sullivan Machinery Co., Chicago, Ill.

ALLOYS.

Ajax Metal Co., Philadelphia, Pa.
American Vanadium Co., Pittsburg, Pa.
Blackwell, Geo., Sons & Co., Ltd., Liverpool, Eng.
Phosphor Bronze Smelting Co., Ltd., Phila., Pa.
Titanium Alloy Mfg. Co., Pittsburg, Pa.

ALUMINO-VANADIUM.

American Vanadium Co., Pittsburg, Pa.

ANALYSIS.

(Mechanical.)
Keep, W. J., Detroit, Mich.

ANNEALING OVENS.

Whiting Foundry Equipment Co., Harvey, Ill.

BABBITT METAL.

Ajax Metal Co., Birmingham, Ala.
Phosphor Bronze Smelting Co., Ltd., Phila., Pa.

BARRELS.

(Factory.)
Cleveland Wire Spring Co., Cleveland, O.

BARROWS.

(Foundry.)
Osborn Mfg. Co., Cleveland, O.
Toledo Wheelbarrow Co., Toledo, O.

BELLOWS.

Dobson, Wm., Canastota, N. Y.
Hill & Griffith Co., Cincinnati, O.
Kelly, T. P., & Co., New York, Chicago, Hamilton.
Obermayer, S., Co., Cincinnati, O.
Osborn Mfg. Co., Cleveland, O.
Paxson Co., J. W., Philadelphia, Pa.
Shanafelt Mfg. Co., Canton, O.
Stevens, Frederic B., Detroit, Mich.
Whitehead Bros. Co.,
Providence, New York, Buffalo.

BLACKING MIXTURES.

Smith, J. D., Fdy. Supply Co., Cleveland, O.

BLOWERS.

American Blower Co., Detroit, Mich.
Connersville Blower Co., Connersville, Ind.
Obermayer, S., Co., Cincinnati, O.
Paxson Co., J. W., Philadelphia, Pa.
Piqua Blower Co., Piqua, O.
Roots, P. H. & F. M., Co., Connersville, Ind.
Sturtevant, B. F., Co., Hyde Park, Mass.

BLOWERS.

(Positive Pressure.)
Connersville Blower Co., Connersville, Ind.
Pangborn Company, Thomas W., New York.
Piqua Blower Co., Piqua, O.
Roots, P. H. & F. M., Co., Connersville, Ind.
Sturtevant, B. F., Co., Hyde Park, Mass.

BOXES.

(Annealing.)
Whiting Fdy. Equipment Co., Harvey, Ill.

BOXES.

(Factory.)
Cleveland Wire Spring Co., Cleveland, O.

BRONZE.

(Manganese.)
Ajax Metal Co., Philadelphia, Pa.
Damascus Bronze Co., Pittsburg, Pa.

BRONZE.

(Vanadium.)
American Vanadium Co., Pittsburg, Pa.

BRUSHES.

Federal Fdry. Supply Co., Cleveland, O.
Hill & Griffith Co., Cincinnati, O.
Manufacturers Brush Co., Cleveland, O.
McCormick Co., J. S., Pittsburg, Pa.
Obermayer, S., Co., Cincinnati, O.
Osborn Mfg. Co., Cleveland.
Paxson Co., J. W., Philadelphia, Pa.
Shanafelt Mfg. Co., Canton, O.
Whitehead Bros. Co.,
Providence, New York, Buffalo.

BUCKETS.

(Grab.)
Pawling & Harnischfeger Co., Milwaukee, Wis.

BURNERS.

(Oil.)
Pangborn Company, Thomas W., New York.
Whiting Fdy. Equipment Co., Harvey, Ill.

CARS.

(Annealing, Pig Iron, Etc.)
Atlas Car & Mfg. Co., Cleveland, O.
Chase Foundry & Mfg. Co., Columbus, O.
Whiting Fdy. Equipment Co., Harvey, Ill.

CARS.

(Charging.)
Whiting Fdy. Equipment Co., Harvey, Ill.

CARS.

(Core Oven.)
Atlas Car & Mfg. Co., Cleveland, O.
Monarch Engrg. & Mfg. Co., Baltimore, Md.
Whiting Fdy. Equipment Co., Harvey, Ill.

CARS.

(Industrial.)
Chase Foundry & Mfg. Co., Columbus, O.
Whiting Fdy. Equipment Co., Harvey, Ill.
Wonham, Sanger & Bates, New York City.

CASTINGS.

(Phosphor-Bronze.)
Phosphor Bronze Smelting Co., Ltd., Phila., Pa.

CASTINGS.

(Steel).
National Brake & Electric Co., Milwaukee, Wis.
Otis Steel Co., Ltd., Cleveland.

CASTINGS.

(Vanadium).
American Vanadium Co., Pittsburg, Pa.

CEMENT.

(Furnace.)
Gautier, J. H., & Co., Jersey City.

CEMENT.

(Iron.)
Clark Cast Steel Cement Co., Shelton, Conn.
McCormick Co., J. S., Pittsburg, Pa.
Obermayer, S., Co., Cincinnati, O.
Osborn Mfg. Co., Cleveland, O.

CEMENT.

(Metallic.)
Clark Cast Steel Cement Co., Shelton, Conn.
Hill & Griffith Co., Cincinnati, O.
Johns-Manville, H. W., Co., New York, N. Y.
Shanafelt Mfg. Co., Canton, O.
Shelton Metallic Filler Co., Derby, Conn.
Smooth-On Mfg. Co., Jersey City.
Whitehead Bros. Co.,
Providence, New York, Buffalo.

CEMENT.

(Steel.)
Clark Cast Steel Cement Co., Shelton, Conn.
Shanafelt Mfg. Co., Canton, O.

CHAPLETS.

Burdick & Son, Albany, N. Y.
Champion Machine & Forging Co., Cleveland.
Cheney & Son, S., Manlius, N. Y.
Federal Foundry Supply Co., Cleveland, O.
Osborn Mfg. Co., Cleveland, O.
Shanafelt Mfg. Co., Canton, O.

CHAPLETS.

(Perforated.)
Hill & Griffith Co., Cincinnati, O.
Obermayer, S., Co., Cincinnati, O.

CHARCOAL.

Silliman, John, Ironton, O.

CHEMISTS.

Davis, Geo. C., Philadelphia, Pa.
Gulick-Henderson & Co., Pittsburg, Pa.
Metallurgical Laboratory, Pittsburg, Pa.
Smith, Rudy & Co., Philadelphia, Pa.

CHIPPERS.

Ingersoll-Rand Co., New York, N. Y.

CINDER MILLS.

Eastern Machinery Co., The, New Haven, Ct.
Sly Mfg. Co., W. W., Cleveland, O.

CLAMPS.

(Flask.)
Barnett, Oscar, Fdy. Co., Irvington, N. J.

COKE.

Baird & West, Detroit, Mich.
Debevoise-Anderson Co., New York.
Hanna & Co., M. A., Cleveland, O.
Hillman, J. H., & Son, Pittsburg, Pa.
Rogers, Brown & Co., Cincinnati, O.
Samuel, Frank, Philadelphia, Pa.
Stevens, Frederic B., Detroit, Mich.

COMPRESSORS.

(Air.)
National Brake & Electric Co., Milwaukee, Wis.

CONVERTERS.

(Side Blown Steel.)
Bretaud, J. V., Sandusky, O.
Stoughton Engineering Co., New York City.
Tropenas Converter Co., New York.
Whiting Fdy. Equipment Co., Harvey, Ill.

COPPER.

(Phosphorized.)
Damascus Bronze Co., Pittsburg, Pa.

CORE BINDERS.

Federal Fdy. Supply Co., Cleveland, O.
Obermayer, S., Co., Cincinnati, O.
Robeson Process Co., Au Sable Forks, N. Y.

CORE COMPOUND.

Hill & Griffith Co., Cincinnati, O.
McCormick Co., J. S., Pittsburg, Pa.
National Core Oil Co., Buffalo, N. Y.
Obermayer, S., Co., Cincinnati, O.
Stevens, Frederic B., Detroit, Mich.
Whitehead Bros. Co.,
Providence, New York, Buffalo.

CORE FLOUR.

Paxson Co., J. W., Philadelphia, Pa.
Piqua Flour Co., Piqua, O.

CORE MACHINES.

Brown Specialty Machinery Co., Chicago, Ill.
Detroit Core Mach. Co., Detroit, Mich.
McCormick Co., J. S., Pittsburg, Pa.
Pangborn Company, Thomas W., New York.
Wadsworth Core Mach. & Equip. Co., Akron, O.
Whitehead Bros. Co.,
Providence, New York, Buffalo.

CORE OIL.

National Core Oil Co., Buffalo, N. Y.
Paxson, J. W., Co., Philadelphia, Pa.
Peterson Co., T. J., Chicago, Ill.
Stevens, Frederic B., Detroit, Mich.
Whitehead Bros. Co.,
Providence, New York, Buffalo.

CORE OIL COMPOUND.

Osborn Mfg. Co., Cleveland, O.
Paxson Co., J. W., Philadelphia, Pa.

CORE OVENS.

Hill & Griffith Co., Cincinnati, O.
McCormick Co., J. S., Pittsburg, Pa.
Millett Core Oven Co., Springfield, Mass.
Monarch Engrg. & Mfg. Co., Baltimore, Md.
Obermayer, S., Co., Cincinnati, O.
Paxson Co., J. W., Philadelphia, Pa.
Rockwell Furnace Co., New York.
Smith, J. D., Foundry Supply Co., Cleveland.
Wadsworth Core Mach. & Equip. Co., Akron, O.
Whiting Fdy. Equipment Co., Harvey, Ill.

CORE.

(Tapering Machines.)
Brown Specialty Machinery Co., Chicago, Ill.
Pangborn Company, Thomas W., New York.

CORE RODS.

(Twisted Steel.)
Franklin Core Rod & Gagger Co., Franklin, Pa.

CORE WASH.

Federal Fdy. Supply Co., Cleveland, O.
Stevens, Frederic B., Detroit, Mich.

CORRESPONDENCE SCHOOLS.

Milwaukee Correspondence Schools, Milwaukee.
Modern Systems Correspondence School,
Boston, Mass.

COUPLINGS.

(Air Hose.)
Cleveland Pneumatic Tool Co., Cleveland, O.

Interior view of Foundry of the Indiana Steel Co., Gary, showing one Morgan 40-ton 4-Motor Crane and one Morgan 25-ton 4-Motor Crane, also two Morgan 5-ton Wall Cranes.

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Pioneer Crane Builders. 3300 Cranes in Successful Operation.
Builders of Hammers, Shears and all kinds of heavy special machinery.

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Foundries who are using our LOCOMOTIVE CRANES say they cannot dispense with them, and that they are the most useful equipments around their plants. We would like to interest you, and wish you would write us for further particulars.

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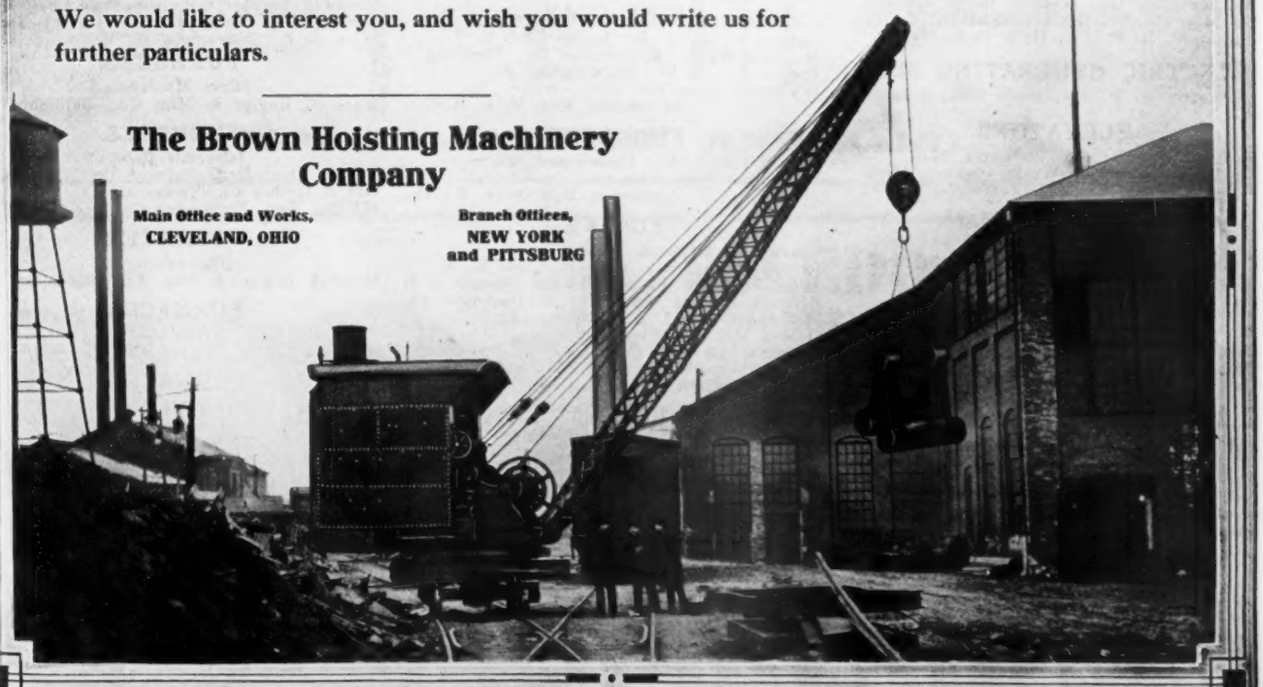
NEW YORK
and PITTSBURG



WHERE TO BUY

CRANES.

Brown Hoisting Machine Co., Cleveland, O.
Cleveland Crane & Engrg. Co., Wickliffe, O.
Curtis & Co. Mfg. Co., St. Louis, Mo.
Maris Bros., Philadelphia, Pa.
Morgan Engineering Co., Alliance, O.
Northern Engineering Works, Detroit, Mich.
Pawling & Harnischfeger Co., Milwaukee, Wis.
Ridgway, Craig & Son, Coatesville, Pa.
Sellers, Wm., & Co., Inc., Philadelphia, Pa.
Shepard Electric Crane & Hoist Co., Montour Falls, N. Y.
Smith, J. D., Fdy. Supply Co., Cleveland, O.
Toledo Bridge & Crane Co., Toledo, O.
Whiting Fdy. Equipment Co., Harvey, Ill.

CRANES.

(Hand Traveling.)

Northern Engineering Works, Detroit, Mich.
Pawling & Harnischfeger Co., Milwaukee, Wis.
Toledo Bridge & Crane Co., Toledo, O.
Whiting Fdy. Equipment Co., Harvey, Ill.

CRUCIBLES.

Barnett, Oscar, Fdy. Co., Irvington, N. J.
Bartley Crucible Co., Jonathan, Trenton, N. J.
Dixon Crucible Co., Jos., Jersey City, N. J.
Gautier, J. H., & Co., Jersey City.
McCullough-Dalzell Crucible Co., Pittsburg, Pa.
Obermayer, S., Co., Cincinnati, O.
Ross-Tacony Crucible Co., Philadelphia, Pa.
Seidel, R. B., Inc., Philadelphia, Pa.

CRUCIBLE FURNACES.

Kroeschell Bros. Co., Chicago, Ill.
Monarch Engrg. & Mfg. Co., Baltimore, Md.

CUPOLAS.

Barry & Zecher Co., Lancaster, Pa.
Northern Engineering Works, Detroit, Mich.
Obermayer, S., Co., Cincinnati, O.
Paxson Co., J. W., Philadelphia, Pa.
Whiting Fdy. Equipment Co., Harvey, Ill.

CUPOLA BLOCK.

Vrooman, H. S., Chicago, Ill.

CUPRO-VANADIUM.

American Vanadium Co., Pittsburg, Pa.

CYLINDERS.

(Vanadium.)

American Vanadium Co., Pittsburg, Pa.

DISCS.

(Grinding.)

Carborundum Co., Niagara Falls, N. Y.

DOWEL PINS.

Obermayer, S., Co., Cincinnati, O.
Shanafelt Mfg. Co., Canton, O.

DRILLS.

(Pneumatic.)

Ingersoll-Rand Co., New York, N. Y.

DUST COLLECTORS.

Cleveland Blow Pipe & Mfg. Co., Cleveland.
Knickerbocker Co., Jackson, Mich.
Sly Mfg. Co., W. W., Cleveland, O.
Sturtevant, B. F., Co., Hyde Park, Mass.

ELECTRIC GENERATING SETS.

Sturtevant, B. F., Co., Hyde Park, Mass.

ELEVATORS.

Curtis & Co. Mfg. Co., St. Louis, Mo.
Northern Engineering Works, Detroit, Mich.
Ridgway, Craig, & Son, Coatesville, Pa.

ELEVATORS.

(Electric.)

Northern Engineering Works, Detroit, Mich.
Whiting Fdy. Equipment Co., Harvey, Ill.

ELEVATORS.

(Pneumatic.)

Northern Engineering Works, Detroit, Mich.
Whiting Fdy. Equipment Co., Harvey, Ill.

EMERY GRINDERS.

Osborn Mfg. Co., Cleveland, O.
Smith, J. D., Fdy. Supply Co., Cleveland, O.

ENGINES.

(Steam.)

American Blower Co., Detroit, Mich.
Sturtevant, B. F., Co., Hyde Park, Mass.

ENGINEERS.

(Foundry, Mech., Elec., Etc.)

Northern Engineering Works, Detroit, Mich.
Pangborn Company, Thomas W., New York.
Smith, J. D., Fdy. Supply Co., Cleveland, O.
Standard Sand & Machine Co., Cleveland, O.
Wonham, Sanger & Bates, New York City.

EQUIPMENT.

(Sand Handling.)

Standard Sand & Machine Co., Cleveland, O.

EXHAUST FANS.

Sturtevant, B. F., Co., Hyde Park, Mass.

FACINGS.

Combined Foundry Supply Co., Buffalo, N. Y.
Dixon Crucible Co., Jos., Jersey City.
Federal Fdy. Supply Co., Cleveland, O.
Hill & Griffith Co., Cincinnati, O.
Kelly, T. P., & Co., New York, Chicago, Hamilton.
Obermayer, S., Co., Cincinnati, O.
Paxson Co., J. W., Philadelphia, Pa.
Pettinos Bros., Bethlehem, Pa.
Stevens, Frederic B., Detroit, Mich.

FANS.

American Blower Co., Detroit, Mich.
Sturtevant, B. F., Co., Hyde Park, Mass.

FASTENERS.

(Corrugated Steel.)

Shanafelt Mfg. Co., Canton, O.

FERRO-ALLOYS.

American Vanadium Co., Pittsburg, Pa.
Blackwell, Geo., Sons & Co., Ltd., Liverpool, Eng.
Primos Chemical Co., Primos, Pa.

FERRO-COMPOUND.

Johns-Manville, H. W., Co., New York, N. Y.

FERRO-MANGANESE.

Rogers, Brown & Co., Cincinnati, O.
Stevens, Frederic B., Detroit, Mich.

FERRO-SILICON.

Roessler & Hasslacher Chemical Co., New York.
Rogers-Brown & Co., Cincinnati-Pittsburg.

FERRO-VANADIUM.

American Vanadium Co., Pittsburg, Pa.
Primos Chemical Co., Primos, Pa.

FILLERS.

(Metallic.)

Clark Cast Steel Cement Co., Shelton, Conn.
Shanafelt Mfg. Co., Canton, O.
Shelton Metallic Filler Co., Derby, Conn.
Smooth-On Mfg. Co., Jersey City, N. J.

FILLETS.

(Leather and Wood.)

Cleveland Fillet Co., The, Cleveland, O.
Obermayer, S., Co., Cincinnati, O.
Shanafelt Mfg. Co., Canton, O.

FIRE BRICK.

Combined Fdy. Supply Co., Buffalo, N. Y.
Gautier, J. H., & Co., Jersey City.
Harbison-Walker Refractories Co., Pittsburg.
Maurer, Henry, & Son, New York City.
Obermayer, S., Co., Cincinnati, O.
Paxson Co., J. W., Philadelphia, Pa.
Valentine, M. D., & Bro., Co., Woodbridge, N. J.
Wonham, Sanger & Bates, New York City.

FIRE CLAY.

Gautier & Co., J. H., Jersey City, N. J.
Harbison-Walker Refractories Co., Pittsburg.
Paxson Co., J. W., Philadelphia, Pa.
Whitehead Bros. Co., Providence, New York, Buffalo.

FIRE SAND.

Paxson Co., J. W., Philadelphia, Pa.
Whitehead Bros. Co., Providence, New York, Buffalo.

FLASKS.

Adams Co., Dubuque, Iowa.
Barnett, Oscar, Fdy. Co., Irvington, N. J.
Brass Founders' Supply Wks. Co., Newark, N. J.
Killing's Molding Mch. Wks., E., Davenport, Ia.
McCormick Co., J. S., Pittsburg, Pa.
Osborn Mfg. Co., Cleveland, O.
Shanafelt Mfg. Co., Canton, O.
Sterling Wheelbarrow Co., West Allis, Wis.
Stevens, Frederic B., Detroit, Mich.

FLASKS.

(Iron.)

Barnett Fdy. Co., Oscar, Irvington, N. J.
Turner Machine Co., Philadelphia, Pa.

FLASKS.

(Snap.)

Adams Co., Dubuque, Iowa.
Brass Founders' Supply Co., Newark, N. J.
Hill & Griffith Co., Cincinnati, O.
Killing's Molding Mch. Wks., E., Davenport, Ia.
Obermayer, S., Co., Cincinnati, O.
Paxson Co., J. W., Philadelphia, Pa.
Shanafelt Mfg. Co., Canton, O.
Smith, J. D., Fdy. Supply Co., Cleveland, O.

FLOUR.

(Core.)

Federal Fdy. Supply Co., Cleveland, O.
Piqua Flour Co., Piqua, O.

FLUOR-SPAR.

Rogers, Brown & Co., Cincinnati, O.
Stevens, Frederic B., Detroit, Mich.

FORGINGS.

Champion Machine & Forging Co., Cleveland.

FORGINGS

(Vanadium.)

American Vanadium Co., Pittsburg, Pa.

FOUNDRY EQUIPMENT.

(Iron and Brass.)

Barnett, Oscar, Fdy. Co., Irvington, N. J.
Hill & Griffith Co., Cincinnati, O.
McCormick Co., J. S., Pittsburg, Pa.
Monarch Engrg. & Mfg. Co., Baltimore, Md.
Northern Engineering Works, Detroit, Mich.
Obermayer, S., Co., Cincinnati, O.
Pangborn Company, Thomas W., New York.
Paxson Co., J. W., Philadelphia, Pa.
Sly, W. W., Mfg. Co., Cleveland, O.
Standard Sand & Mach. Co., Cleveland, O.
Stevens, Frederic B., Detroit, Mich.
Whiting Fdy. Equipment Co., Harvey, Ill.
Wonham, Sanger & Bates, New York City.

FOUNDRY SUPPLIES.

Birkenstein & Sons, Chicago, Ill. (Brass.)
Combined Fdy. Supply Co., Buffalo, N. Y.
Federal Fdy. Supply Co., Cleveland, O.
Hill & Griffith Co., Cincinnati, O.
Kelly, T. P., & Co., New York, Chicago, Hamilton.
Obermayer, S., Co., Cincinnati, O.
Osborn Mfg. Co., Cleveland, O.
Pangborn Company, Thomas W., New York.
Paxson Co., J. W., Philadelphia, Pa.
Shanafelt Mfg. Co., Canton, O.
Smith, J. D., Fdy. Supply Co., Cleveland, O.
Standard Sand & Machine Co., Cleveland, O.
Stevens, Frederic B., Detroit, Mich.
Whitehead Bros. Co., Providence, New York, Buffalo.

FUEL BURNING APPLIANCES.

(Oil.)

Hauck Mfg. Co., Brooklyn, N. Y.

FURNACES.

Best, W. N., New York.
Hawley Down-Draft Furnace Co., Chicago, Ill.
Monarch Engrg. & Mfg. Co., Baltimore, Md.
Rockwell, W. S., Co., New York, N. Y.
Smith, J. D., Fdy. Supply Co., Cleveland, O.

FURNACES.

(Annealing.)

Monarch Engrg. & Mfg. Co., Baltimore, Md.

FURNACES.

(Brass.)

Hawley Down-Draft Furnace Co., Chicago, Ill.
Kroeschell Bros. Co., Chicago, Ill.
Monarch Engrg. & Mfg. Co., Baltimore, Md.
Paxson Co., J. W., Philadelphia, Pa.
Rockwell Furnace Co., New York.
Whiting Fdy. Equipment Co., Harvey, Ill.
Wise, J. B., Watertown, N. Y.

FURNACES.

(Case Hardening.)

Monarch Engrg. & Mfg. Co., Baltimore, Md.

FURNACES.

(Crucible Steel.)

Hawley Down-Draft Furnace Co., Chicago, Ill.
Hill & Griffith Co., Cincinnati, O.
Whiting Fdy. Equipment Co., Harvey, Ill.

FURNACES.

(Galvanizing.)

Monarch Engrg. & Mfg. Co., Baltimore, Md.

FURNACES.

(Heating.)

Monarch Engrg. & Mfg. Co., Baltimore, Md.

FURNACES.

(Malleable Iron.)

Best, W. N., New York.
Whiting Fdy. Equipment Co., Harvey, Ill.

FURNACES.

(Melting.)

Barnett, Oscar, Fdy. Co., Irvington, N. J.
Hawley Down-Draft Furnace Co., Chicago, Ill.
Kroeschell Bros. Co., Chicago, Ill.
Monarch Engrg. & Mfg. Co., Baltimore, Md.
Northern Engineering Works, Detroit, Mich.
Obermayer, S., Co., Cincinnati, O.
Paxson Co., J. W., Philadelphia, Pa.
Rockwell Furnace Co., New York.
Rockwell, W. S., Co., New York, N. Y.
Wise, J. B., Watertown, N. Y.

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Hand Power Traveling Crane.
Chain Sprocket Hoist, two speed lift.

Single I Beam Type.

Maris Brothers
Philadelphia, Pa.

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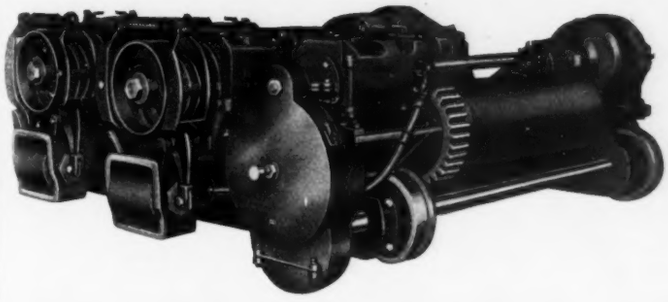

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C. E. Stamp & Co., Cleveland, Ohio
The Cincinnati Iron & Steel Co., Cincinnati, Ohio
The Fairbanks Co., Philadelphia, Pa.

WHERE TO BUY

FURNACES.

(Oil.)

Hauck Mfg. Co., Brooklyn, N. Y.
Hawley Down-Draft Furnace Co., Chicago, Ill.
Kroeschell Bros. Co., Chicago, Ill.
Monarch Engrg. & Mfg. Co., Baltimore, Md.
Rockwell Furnace Co., New York.

FURNACES.

(Open Hearth Steel.)

Whiting Fdy. Equipment Co., Harvey, Ill.

FURNACES.

(Reverberatory.)

Monarch Engrg. & Mfg. Co., Baltimore, Md.

FURNACES.

(Soft Metal Melting.)

Kroeschell Bros. Co., Chicago, Ill.
Monarch Engrg. & Mfg. Co., Baltimore, Md.
Wise, J. B., Watertown, N. Y.

FURNACES.

(Tilting.)

Kroeschell Bros. Co., Chicago, Ill.
Wise, J. B., Watertown, N. Y.

GAGGERS.

(Twisted Steel.)

Franklin Core Rod & Gagger Co., Franklin, Pa.

GEARS.

(Vanadium.)

American Vanadium Co., Pittsburg, Pa.

GLUE.

Masek, C., Co., Cleveland, O.

GOVERNORS.

(Float, Switches and Pressure.)

General Electric Co., Schenectady, N. Y.

GRAPHITE.

Dixon Crucible Co., Jos., Jersey City, N. J.
Hill & Griffith Co., Cincinnati, O.
McCormick Co., J. S., Pittsburg, Pa.
Obermayer, S., Co., Cincinnati, O.
Paxson Co., J. W., Philadelphia, Pa.
Pettinos Bros., Bethlehem, Pa.

GRINDERS.

(Pneumatic Portable.)

Cleveland Pneumatic Tool Co., Cleveland, O.

GRINDING MACHINERY.

Adams Co., Dubuque, Iowa.
Crescent Machine Co., Leetonia, O.
Osborn Mfg. Co., Cleveland, O.

GRINDING TOOLS.

Coates Clipper Mfg. Co., Worcester, Mass.
Stow Mfg. Co., Binghamton, N. Y.

HAMMERS.

(Chipping.)

Coates Clipper Mfg. Co., Worcester, Mass.

HAMMERS.

Independent Pneumatic Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York City.

HEATERS.

(Feed Water.) (Ladle.)

Hawley Down-Draft Furnace Co., Chicago, Ill.

HEATING AND VENTILATING APPARATUS.

American Blower Co., Detroit, Mich.
Sturtevant, B. F., Co., Hyde Park, Mass.

HOISTS.

Brown Hoisting Mach. Co., Cleveland, O.
Northern Engineering Works, Detroit, Mich.
Sellers, Wm., & Co., Inc., Philadelphia, Pa.
Shepard Electric Crane & Hoist Co., Montour Falls, N. Y.
Whiting Fdy. Equipment Co., Harvey, Ill.
Yale & Towne Mfg. Co., New York.

HOISTS.

(Chain.)

Whiting Fdy. Equipment Co., Harvey, Ill.
Yale & Towne Mfg. Co., New York.

HOISTS.

(Electric.)

Euclid Crane & Hoist Co., Euclid, O.
Northern Engineering Works, Detroit, Mich.
Pawling & Harnischfeger Co., Milwaukee, Wis.
Sprague Electric Co., New York City.
Whiting Fdy. Equipment Co., Harvey, Ill.
Yale & Towne Mfg. Co., New York.

HOISTS.

(Hand.)

Northern Engineering Works, Detroit, Mich.
Whiting Fdy. Equipment Co., Harvey, Ill.
Yale & Towne Mfg. Co., New York.

HOISTS.

(Pneumatic.)

Curtis & Co. Mfg. Co., St. Louis, Mo.
Independent Pneumatic Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York, N. Y.
Northern Engineering Works, Detroit, Mich.
Ridgway, Craig & Son, Coatesville, Pa.
Whiting Fdy. Equipment Co., Harvey, Ill.

HOSE.

(Pneumatic.)

Cleveland Pneumatic Tool Co., Cleveland, O.

INDUSTRIAL RY. EQUIPMENT

Atlas Car & Mfg. Co., Cleveland, O.
Johns-Manville, H. W., Co., New York, N. Y.
Northern Engineering Works, Detroit, Mich.

IRON ORE.

Rogers, Brown & Co., Cincinnati, O.

KAOLIN.

Whitehead Bros. Co., Providence, New York, Buffalo.

LADLES.

McCormick Co., J. S., Pittsburg, Pa.
Northern Engineering Works, Detroit, Mich.
Osborn Mfg. Co., Cleveland, O.
Paxson Co., J. W., Philadelphia, Pa.
Stevens, Frederic B., Detroit, Mich.
Whiting Fdy. Equipment Co., Harvey, Ill.

LADLE DRYERS.

Pangborn Company, Thomas W., New York.

LADLE HEATERS.

Monarch Engrg. & Mfg. Co., Baltimore, Md.
Pangborn Company, Thomas W., New York.
Rockwell Furnace Co., New York.

LAMPS.

(Arc.)

Adams-Bagnall Electric Co., Cleveland, O.

LEAD.

Federal Fdy. Supply Co., Cleveland, O.
McCormick Co., J. S., Pittsburg, Pa.
Stevens, Frederic B., Detroit, Mich. (Ceylon.)

LEAD.

(Black.)

Federal Fdy. Supply Co., Cleveland, O.
McCormick Co., J. S., Pittsburg, Pa.

MACHINERY.

(Wood Working.)

Crescent Machine Co., Leetonia, O.

MATCH-PLATES.

B. & G. Mfg. Co., Chicago, Ill.

MECHANICAL DRAFT APPARATUS.

Sturtevant, B. F., Co., Hyde Park, Mass.

METALS.

Birkenstein & Sons, S., Chicago, Ill.
Damascus Bronze Co., Pittsburg, Pa.

METALLURGISTS.

Stoughton Engineering Co., New York City.

MODELS.

(Made to Order.)

Freeman Pattern Works, Toledo, O.

MOLD DRYERS.

Hanna Engineering Works, Chicago, Ill.
Hauck Mfg. Co., Brooklyn, N. Y.
Monarch Engrg. & Mfg. Co., Baltimore, Md.
Pangborn Company, Thomas W., New York.

MOLDING MACHINES.

Adams Co., Dubuque, Iowa.
Arcade Mfg. Co., Freeport, Ill.
Ardelt & Sons, Eberswalde, Germany.
Berkshire Mfg. Co., Cleveland, O.
Buch's Sons, Elizabethtown, Pa.
Combined Foundry Supply Co., Buffalo, N. Y.
Herman Pneumatic Mach. Co., Zelienople, Pa.
Killing's Molding Mch. Wks., E., Davenport, Ia.
Lawlor Improved Jarring Molding Machine Co., J. J., Pittsburg, Pa.
Mumford Molding Mach. Co., New York City.
Osborn Mfg. Co., Cleveland, O.
Paxson Co., J. W., Philadelphia, Pa.
Pridmore Co., Edward A., Chicago, Ill.
Pridmore, Henry E., Chicago, Ill.
Smith, J. D., Fdy. Supply Co., Cleveland, O.
Tabor Mfg. Co., Philadelphia, Pa.
Turner Machine Co., Philadelphia, Pa.

PACKING.

(Rubber Sheet.)

Smooth-On Mfg. Co., Jersey City.

PARTING.

Curtius, Thos. M., New York City.

PARTING COMPOUNDS.

Federal Fdry. Supply Co., Cleveland, O.
Obermayer, S., Co., Cincinnati, O.
Osborn Mfg. Co., Cleveland, O.
Paxson Co., J. W., Philadelphia, Pa.
Whitehead Bros. Co., Providence, New York, Buffalo.

PATTERN LETTERS.

Cleveland Fillet Co., The, Cleveland, O.
Hill & Griffith Co., Cincinnati, O.
Obermayer, S., Co., Cincinnati, O.
Osborn Mfg. Co., Cleveland, O.
Paxson Co., J. W., Philadelphia, Pa.
Shanafelt Mfg. Co., Canton, O.

PATTERN LUMBER.

Neill & Spanjer, Newark, N. J.
Thompson, Lewis & Co., Philadelphia, Pa.

PATTERNS.

(Metal and Wood.)

Freeman Pattern Works, Toledo, O.
Herman Pneumatic Mach. Co., Zelienople, Pa.
Standard Pattern Works Co., Cleveland, O.

PHOSPHORIZERS.

Dixon Crucible Co., Jos., Jersey City, N. J.
McCullough-Dalzell Crucible Co., Pittsburg, Pa.

PIG IRON.

Addy, Matthew, & Co., Cincinnati, O.
Breen, Wm. J., Co., Boston, Mass.
Goodrich, F. A., & Co., Detroit, Mich.
Hanna & Co., M. A., Cleveland, O.
McKeefrey & Co., Leetonia, O.
Mohr, J. J., Philadelphia, Pa.
Nash, Isham, & Co., New York.
Perry Iron Co., Erie, Pa.
Pickands, Mather & Co., Cleveland, O.
Pilling & Crane, Philadelphia, Pa.
Rogers, Brown & Co., Cincinnati, O.
Samuel, Frank, Philadelphia, Pa.
Thomas Furnace Co., Milwaukee, Wis.
Walter-Wallingford & Co., Cincinnati and Pittsburg.

PIPE COVERING.

Johns-Manville, H. W., Co., New York, N. Y.

PLUMBAGO.

Dixon Crucible Co., Jos., Jersey City, N. J.
Federal Fdy. Supply Co., Cleveland, O.
Fernando, W. A., Colombo, Ceylon.
Gautier, J. H., & Co., Jersey City.
Hill & Griffith Co., Cincinnati, O.
McCullough-Dalzell Crucible Co., Pittsburg, Pa.
Obermayer, S., Co., Cincinnati, O.
Paxson Co., J. W., Philadelphia, Pa.
Pettinos Bros., Bethlehem, Pa.
Ross-Tacony Crucible Co., Philadelphia, Pa.
Smith, J. D., Foundry Supply Co., Cleveland.
Stevens, Frederic B., Detroit, Mich.
Whitehead Bros. Co., Providence, New York, Buffalo.

POLISHING MACHINES.

Osborn Mfg. Co., Cleveland, O.

POLISHERS' AND PLATERS' SUPPLIES.

Osborn Mfg. Co., Cleveland, O.
Springfield Tire & Rubber Co., Springfield, O. (Polishing Wheels.)
Stevens, Frederic B., Detroit, Mich.

POLISHING OUTFITS.

(Stoves.)

Coates Clipper Mfg. Co., Worcester, Mass.

RAMMERS.

(Bench.)

Ingersoll-Rand Co., New York, N. Y.
Obermayer, S., Co., Cincinnati, O.

RHEOSTATS.

(Field and Battery Charging.)

General Electric Co., Schenectady, N. Y.

JIGGY, JIGGY, JIGGY, JIGGY, JIGGY

That's the way she runs isn't it?

That old elevator of yours is crawling up and down your foundry like an ice wagon.

And liable to jerk itself down at any time and hurt or kill somebody.

Of course you are "too poor" to have a decent up and down stairs transportation to keep your foundry on the jump.

But we note you buy a good machine for your pleasure—that automobile for example, what did you pay for it?

And can't take a little money to have a decent elevator to handle stuff up and down stairs.

Oh you Great Manager—no wonder a hundred other foundries are calling you to come and run them!

Say, old fellow, get sane. Don't let them fool you on cheap elevators.

Look around you and see the great foundries which are installing these wonderful Ridgway Steam Hydraulic Elevators and then go visit them and find out for yourself what it means to

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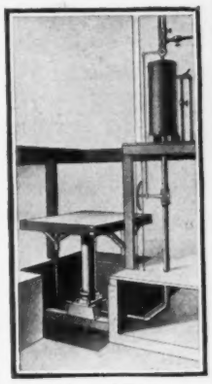
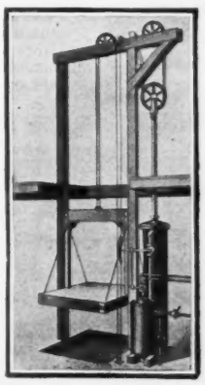
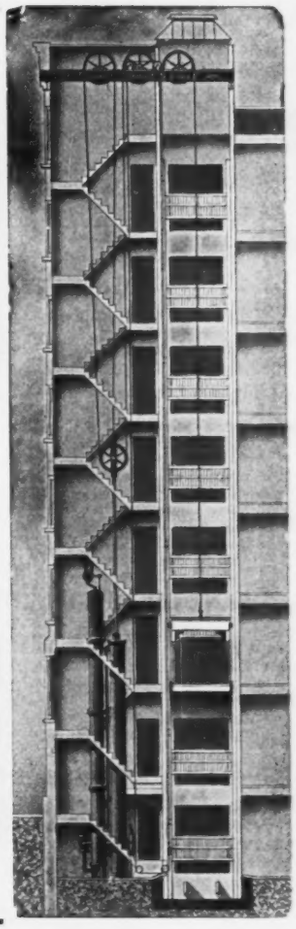


Direct Acting



Double Geared



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RIDDLES.

Adams Co., Dubuque, Iowa.
Federal Fdy. Supply Co., Cleveland, O.
Obermayer, S., Co., Cincinnati, O.
Osborn Mfg. Co., Cleveland, O.
Paxson Co., J. W., Philadelphia, Pa.
Smith, J. D., Foundry Supply Co., Cleveland.
Whitehead Bros. Co.,
Providence, New York, Buffalo.

RIDDLES.

(Dumping.)
Hanna Engineering Works, Chicago, Ill.

RIVETERS.

Hanna Engineering Works, Chicago, Ill.

RUNWAYS.

(Crane.)
Whiting Fdy. Equipment Co., Harvey, Ill.

SAND.

Albany Sand & Supply Co., Albany, N. Y.
Brass Founders' Supply Co., Newark, N. J.
Federal Fdy. Supply Co., Cleveland, O.
Franklin Silica Sand Co., Franklin, Pa.
Newport Sand Bank Co., Newport, Ky.
Obermayer, S., Co., Cincinnati, O.
Ottawa Silica Co., Ottawa, Ill.
Pangborn Company, Thomas W., New York.
Pettinos Bros., Bethlehem, Pa.
Standard Sand & Mch. Co., Cleveland, O.
Whitehead Bros. Co.,
Providence, New York, Buffalo.

SAND BLAST MACHINERY.

Betton, J. M., New York, N. Y.
Mott Sand Blast Mfg. Co., Chicago, Ill.
Obermayer, S., Co., Cincinnati, O.
Pangborn Company, Thomas W., New York.
Paxson Co., J. W., Philadelphia, Pa.
Smith, J. D., Foundry Supply Co., Cleveland.
Tilghman-Brooksbank Sand Blast Co.,
Philadelphia, Pa.

SAND BLAST SYSTEMS.

Mott Sand Blast Mfg. Co., Chicago, Ill.
Pangborn Company, Thomas W., New York.
Smith, J. D., Foundry Supply Co., Cleveland.
Tilghman-Brooksbank Sand Blast Co.,
Philadelphia, Pa.

SAND BLAST TUMBLING BARRELS.

Betton, J. M., New York, N. Y.
Pangborn Company, Thomas W., New York.
Tilghman-Brooksbank Sand Blast Co.,
Philadelphia, Pa.

SAND MIXING MACHINERY.

Blystone Mfg. Co., Cambridge Springs, Pa.
McCormick Co., J. S., Pittsburg, Pa.
Mumford Molding Machine Co., New York.
Obermayer, S., Co., Cincinnati, O.
Pangborn Company, Thomas W., New York.
Sand Mixing Machine Co., New York City.
Sellers, Wm., & Co., Inc., Philadelphia, Pa.
Standard Sand & Machine Co., Cleveland. O.
Wadsworth Core Mach. & Equip. Co., Akron, O.

SAND SIFTERS.

Deane Steam Pump Co., Holyoke, Mass.
Hanna Engineering Works, Chicago, Ill.
Herman Pneumatic Mach. Co., Zelienople, Pa.
Hill & Griffith Co., Cincinnati, O.
Killing's Molding Mch. Wks., E., Davenport, Ia.
Obermayer, S., Co., Cincinnati, O.
Osborn Mfg. Co., Cleveland, O.
Pangborn Company, Thomas W., New York.
Paxson, J. W., Co., Philadelphia, Pa.
Standard Sand & Mach. Co., Cleveland, O.
Turner Machine Co., Philadelphia, Pa.

SASH.

(Window.)
Detroit Steel Products Co., Detroit, Mich.

SAWS.

(Cold Cutting.)
Tabor Mfg. Co., Philadelphia, Pa.

SCREENS.

(Sand.)
Osborn Mfg. Co., Cleveland, O.
Standard Sand & Machine Co., Cleveland, O.

SEACOAL.

Federal Fdy. Supply Co., Cleveland, O.
Hill & Griffith Co., Cincinnati, O.
McCormick, J. S. Co., Pittsburg, Pa.
Obermayer, S., Co., Cincinnati, O.
Paxson, J. W., Co., Philadelphia, Pa.
Stevens, Frederic B., Detroit, Mich.
Whitehead Bros. Co.,
Providence, New York, Buffalo.

SEPARATORS.

(Magnetic.)
Obermayer, S., Co., Cincinnati, O.
Pangborn Company, Thomas W., New York.
Paxson, J. W., Co., Philadelphia, Pa.

SHAFTING.

(Flexible.)
Stow Mfg. Co., Birmingham, N. Y.

SHOVELS.

Federal Fdy. Supply Co., Cleveland, O.
Obermayer, S., Co., Cincinnati, O.
Osborn Mfg. Co., Cleveland, O.
Paxson, J. W., Co., Philadelphia, Pa.
Whitehead Bros. Co.,
Providence, New York, Buffalo.

SMOKE CONDENSERS.

Hawley Down-Draft Furnace Co., Chicago, Ill.

SPRINGS.

(Vanadium.)
American Vanadium Co., Pittsburg, Pa.

SPRUE CUTTERS.

Barnett, Oscar, Foundry Co., Irvington, N. J.
Shuster, F. B., Co., New Haven, Conn.
Smith, J. D., Foundry Supply Co., Cleveland.
Turner Machine Co., Philadelphia, Pa.

STARTERS.

(Hand and Self, A. C. and D. C.)
General Electric Co., Schenectady, N. Y.

STEEL.

(Vanadium.)
American Vanadium Co., Pittsburg, Pa.

STOPPERS.

Bartley, Jonathan, Crucible Co., Trenton, N. J.
Dixon Crucible Co., Jos., Jersey City, N. J.
McCullough-Dalzell Crucible Co., Pittsburg, Pa.
Ross-Tacony Crucible Co., Philadelphia, Pa.

SWABS.

(Molders'.)
Osborn Mfg. Co., Cleveland, O.

TESTING MACHINES.

Keep, W. J., Detroit, Mich.

TONGS.

(Crucible.)
Whiting Fdy. Equipment Co., Harvey, Ill.

TOOLS.

(Molders'.)
Dobson, William, Canastota, N. Y.
Federal Fdy. Supply Co., Cleveland, O.
Obermayer, S., Co., Cincinnati, O.
Osborn Mfg. Co., Cleveland, O.

TOOLS.

(Pneumatic.)
Ingersoll-Rand Co., New York, N. Y.
Pittsburg Pneumatic Tool Co., Canton, O.

TORCHES.

Hauck Mfg. Co., Brooklyn, N. Y.

TRACK.

(Industrial.)
Whiting Fdy. Equipment Co., Harvey, Ill.

TRAMRAIL SYSTEMS.

Northern Engineering Works, Detroit, Mich.
Randall Tramrail Co., Philadelphia, Pa.
Rockwell Furnace Co., New York.
Whiting Fdy. Equipment Co., Harvey, Ill.
Yale & Towne Mfg. Co., New York.

TROLLEYS.

Northern Engineering Works, Detroit, Mich.
Whiting Fdy. Equipment Co., Harvey, Ill.
Yale & Towne Mfg. Co., New York City.

TROLLEY SYSTEMS.

Smith, J. D., Foundry Supply Co., Cleveland.

TRUCKS.

Northern Engineering Works, Detroit, Mich.

TUMBLING BARRELS.

Betton, J. M., New York City.
McCormick, J. S., Co., Pittsburg, Pa.
Northern Engineering Works, Detroit, Mich.
Osborn Mfg. Co., Cleveland, O.
Paxson, J. W., Co., Philadelphia, Pa.
Smith, J. D., Foundry Supply Co., Cleveland.
Whiting Fdy. Equipment Co., Harvey, Ill.

TUMBLING MILLS.

Adams Co., Dubuque, Iowa.
McCormick, J. S., Co., Pittsburg, Pa.
Sly, W. W., Mfg. Co., Cleveland, O.
Wadsworth Core Mach. & Equip. Co., Akron, O.

TURNTABLES.

Northern Engineering Works, Detroit, Mich.
Whiting Fdy. Equipment Co., Harvey, Ill.

VANADIUM.

American Vanadium Co., Pittsburg, Pa.

VENTILATORS.

Royal Ventilator & Mfg. Co., Philadelphia, Pa.

VIBRATORS.

(Compressed Air.)
Osborn Mfg. Co., Cleveland, O.

WAX.

(Core.)
United Compound Co., Buffalo, N. Y.

WHEELBARROWS.

McCormick Co., J. S., Pittsburg, Pa.
Toledo Wheelbarrow Co., Toledo, O.

WHEELS.

(Grinding.)
Carborundum Co., Niagara Falls, N. Y.

WHITE FINISH.

Osborn Mfg. Co., Cleveland, O.

WIRE CLEANING WHEELS.

Osborn Mfg. Co., Cleveland, O.

WIRE STRAIGHTENERS.

Blake, Geo. F., Mfg. Co., New York City.
Gregg Mfg. Co., Cleveland, O.
Pangborn Company, Thomas W., New York.
Shuster, F. B., Co., New Haven, Conn.

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